

**CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH  
SCIENCE COUNCIL**

**Report of the  
Fifth External Program and Management Review (EPMR)  
of the Africa Rice Center (WARDA)**

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## SUMMARY AND RECOMMENDATIONS

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### Introduction

This 5th External Program and Management Review (EPMR) of WARDA (Africa Rice Center) comes at an important transition point in its recent history. The 4th EPMR, completed in 2000, was unfortunately followed in 2002 by a forced relocation of the Center's headquarters from Côte d'Ivoire to Mali, and then to Benin in 2005. The Center is now well established in its temporary headquarters in Cotonou, and the research program has been maintained despite the two relocations. The current period of transition is the result of a change of leadership at the Center in October 2006, the implementation of the new Director General's "vision" for the Center, and WARDA's ongoing realignment of the Center's program, governance and corporate services with other CGIAR Centers, primarily IRRI and CIAT (for programmatic matters) and IITA (for governance and corporate services).

The Panel's report covers these and other areas, in accordance with the EPMR's terms of reference. We also address the strategic questions formulated by the Science Council to help direct the Panel's attention to key issues facing the Center. The implementation of the recommendations of the 4th EPMR indicates that most of these recommendations have been implemented or were overtaken by events (see Annex VII).

Our overall conclusion is that the Center has weathered the "Ivorian crisis" remarkably well, has been guided by an effective Board of Trustees, has been ably led by its senior managers, has continued to do reasonably good research and maintained functioning corporate services, and is now poised to launch a period of phased growth. Such growth would emphasize high quality scientific research in partnership with the NARS of Africa and advanced research institutions elsewhere.

This continuing evolution of the research program and administration would, however, need to be carefully guided by the Board and effectively and efficiently managed by Center leadership and staff. The Panel hopes that its review of all major aspects of the Center, the analyses done and conclusions reached by the Panel, and the suggestions and recommendations made in various sections of this report will help the Center progress steadily toward an exciting future.

### The Continuing Need for WARDA

During the last decade, rice has become the most rapidly growing food source in Sub-Saharan Africa (SSA). Relative growth for demand for rice is faster in SSA than anywhere else in the world. This is due to population growth and a shift in consumer preference for rice, especially in urban areas; and this is happening in West and Central Africa (WCA) as well as in East and Southern Africa (ESA). In West Africa, 29% of the total production of rice in 1999/2003 was from the upland ecosystem, 36% from the lowland ecosystem, and 26% from irrigated fields.

WARDA has rice research programs in these three ecosystems; and works closely with its regional and national partners. It is in a position to contribute to rice development, which, according to CORAF/WE CARD's Strategic Plan (2000) and a recent study by IFPRI-IITA-CORAF/WE CARD and ECOWAS (2006), is potentially the best driver of development for SSA—the locomotive that will pull growth and poverty reduction in the sub-region. In the Panel's

view, WARDA's mission, aimed at increasing the productivity and profitability of the rice sector while ensuring the sustainability of the farming environment, remains relevant and appropriate.

## **Main Findings and Conclusions**

The Panel's main findings and conclusions are detailed in the various chapters of the report. Selected highlights are provided below:

***Program relevance and quality:*** WARDA has conducted very relevant work focusing both on genetic and non-genetic solutions to rice production systems in Africa. The achievements are many, and are in line with its mission and CGIAR system priorities. The relevance and the quality of science at WARDA could, however, be greatly improved if the current research priority setting process is improved, and research planning incorporates greater inter-disciplinarity. There is a need for better targeting of research activities, using a stratification of the biophysical and socio-economic environment, focusing only on a few constraints of regional importance. Then, appropriate crop improvement and NRM management solutions could be specifically developed and disseminated to the target areas, ensuring better adoption by farming communities.

Resource allocation between the major rice ecologies is satisfactory, and responds to the need for intensification of research on the irrigated and rainfed lowlands. The Center needs to place more emphasis on strategic rather than applied research, and should identify and strengthen strategic partners for product delivery. Moreover, a better balance between breeding and NRM research activities should be ensured. WARDA's role should be better demarcated from that of NARS, based on their respective missions and comparative advantages.

Very good progress has been made in the implementation of measures to ensure quality of science. Good progress has also been made in terms of the development of rice varieties. The publication record of WARDA is good in number and in quality, though the number of papers per scientist is somewhat below the average for CGIAR Centers. WARDA is under-staffed in some areas of research. Steps need to be taken to improve critical mass, and to use researchers primarily for scientific rather than networking activities.

***Genetic improvement program:*** The Panel notes that 18 upland, 60 lowland and 3 irrigated varieties of NERICA (New Rice for Africa), and several additional *Oryza sativa* varieties have been developed and released during 2000-2006; and that there has been a large improvement in the rate of success of interspecific crosses between *O. glaberrima* and *O. sativa*, the two parents of NERICAs. Excellent work has been done on the genetic diversity of *O. glaberrima*. But further in-depth large-scale phenotypic evaluation of its valuable traits is needed. The future objectives of this work could be to establish core collections of *O. glaberrima*, and to undertake genome association mapping to locate genes with precision and to identify interesting alleles at these genes.

NERICAs have so far been viewed as a "silver bullet". However, in order to broaden impact, there is need for improved stratified analyses of the environment (agro-ecological as well as socio-economic) and a definition of homogeneous target zones with their associated ideotypes. The results of this stratification should be factored into Participatory Varietal Selection approaches, in order for breeders, agronomists, and socio-economists to better understand the reasons behind the variability of varietal performances and farmers' choices.



During the review period, very good collaborative work has been done on the understanding of the genetic control of some traits, leading to the cloning of a RYMV resistance gene. Similar work has started for the major abiotic stresses. All elements, including the availability of several useful genes, are in place for NARS to begin marker-aided selection programs.

***Natural resource management:*** WARDA's research on NRM addresses the main soil, nutrient, water, weed, pest and disease constraints in West Africa. In the Panel's view, this work is relevant, of good scientific quality, and needs to be given more emphasis in the future (including in the Center's documentation and communication efforts). In terms of future NRM research at WARDA, since the mechanisms and processes behind NERICAs' productive potential are generally unknown, the Panel suggests research in a number of areas, including a better understanding of mechanisms associated with nutrient-use efficiency, water-use efficiency and productivity, resistance to pests and diseases, protein content, and weed competitiveness. It is important that the target trait be well defined, and that the traits of progenies be examined agro-physiologically.

The cropping systems approach to agronomy research is appropriate, but future work should focus on development of crop and natural resources management practices that lead to sustainability of yields (maintain or improve crop productivity in the medium- and long-term) and land resources. In view of the growing water scarcity and competing demands between agriculture and other uses, there is need to strengthen WARDA's research on water management to improve rice productivity, including research on institutional and policy issues of irrigation systems and their impact on water costs and the profitability of rice production. WARDA needs to strengthen critical mass in this area, both at Center and at national institutions. A strategy for weed management for the rainfed lowlands and uplands is also needed, as WARDA until now has mainly focused on NERICAs' presumed weed competitiveness, something that the Panel could not confirm during field visits. More work on integrated pest management is also needed.

***Social sciences and adoption and impact studies:*** WARDA's social scientists have been doing good social science research, including research on adoption and impact. Notable examples are the Participatory Learning and Action Research (PLAR) method for technology transfer, and a new methodology for undertaking adoption studies. However, WARDA's adoption and impact studies have been limited by their "snapshot" approach. More generally, the Panel had difficulty understanding the results of WARDA's adoption and impact studies, perhaps because the agro-ecologic and socio-economic contexts of such studies are not sufficiently clear and explicit. So many constraints operate on adoption that involving interdisciplinary teams from WARDA's other research programs may help. In addition, while the Agricultural Policy Research Advocacy Group (APRAG), WARDA's Council of Ministers (COM) and National Experts Committee (NEC) are very good mechanisms to influence policy, they require a sharper focus on rice policy and its links to agricultural development. The feedback of the results of such studies to the technology developers, particularly breeders also seems to be lacking. The Panel feels that had several social science staff positions not remained vacant for so long, the contribution of social sciences would have increased and improved significantly.

Finally, the seed issue remains a critical constraint, and WARDA needs to delve into understanding farmers' rationale for purchasing and storing seed. There is a need for better data on areas under modern rice varieties, on improved agronomic practices, and rice markets and policy. A multi-agency workshop on the issue is suggested.

**Training and capacity building:** Training and capacity building are an integral part of the research program at WARDA, particularly since many NARS are still weak and lack well-trained staff. WARDA has put a major effort into training of NARS scientists in breeding, including using molecular techniques, but NRM training, particularly on soil and water management, needs attention in the future. The Panel endorses the newly proposed post-masters internship program as an innovative approach. However, more and better linkages with higher education institutions in Africa should be sought, including linkages complementing outsourcing of training activities for NARS.

**Partnerships:** WARDA embraces and values networks and partnerships, and this is to be commended. “Partnerships at all levels” is a WARDA motto, and the Panel has confirmed that this is not an empty phrase. “WARDA, that is us”, as said by its partners, typifies their special relationship with the Center. On the many questions regarding critical mass, WARDA’s responses invariably included NARS scientists.

However, while the outcomes of partnerships and networks are unquestionably positive, they have come at high transaction costs. In the Panel’s view, partnerships should not substitute the need for critical mass at WARDA, to guarantee science quality. Furthermore, WARDA’s specific role in its partnerships needs to move upstream, seeking collaborations that are more science oriented. At the same time, WARDA needs to learn more from its partners, from their field experiences and the downstream Genotype x Environment interactions, and use this feedback more systematically in its own research.

**Governance and management:** The Panel notes that during the period under review, WARDA has had to face extraordinary circumstances beyond its control. The 4<sup>th</sup> EPMR recommendations on governance and management have largely been implemented, or were overtaken by events. The difficulty of guiding and managing a Center repeatedly uprooted from its home country and headquarters location due to violent civil unrest should not be minimized, nor should the time and effort needed to firmly re-establish it on a firm footing in subsequent years. WARDA has only now emerged from this five-year period of uncertainty and flux. In spite of this, in recent years, WARDA has performed reasonably well in terms of the CGIAR Performance Measurement System that includes a comparative assessment of governance, as well as financial and other management-related performance measures included in the CGIAR report for 2006.

In the Panel’s view, governance at WARDA is reasonably good, though program oversight could be improved. Management of research and corporate services has improved, but there is room for further strengthening in several areas. The Center is still undergoing a further period of transition — with a new Director General, a new “vision” and a research organization introduced by him soon thereafter, and several new staff in important positions. In addition, it is expected that the planned alignment of corporate services between WARDA and IITA (Benin) will be completed by end-2007; a new ADG for Research and Development will be appointed upon the retirement of the current incumbent sometime during 2008; and programmatic alignment between WARDA and other CGIAR Centers will accelerate.

It seems to the Panel that during the next 3-5 years, WARDA would benefit from a period of Board-guided and Management-orchestrated stability and consolidation phase, which would nevertheless introduce necessary changes in governance and management in a systematic and prudent manner. The Panel believes that once these changes are in place, WARDA will have the

capacity to deliver on a more ambitious rice research program, enhanced and strengthened by the collaboration with IRRI and CIAT, in the coming years.

**WARDA tomorrow:** The Panel is optimistic about WARDA's future. It visualizes a stronger and larger rice research Center serving all of Sub-Saharan Africa, in collaboration with WARDA's many NARS and international partners.

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## RECOMMENDATIONS

### Rice genetic improvement

1. Because phenotypic variability of *Oryza. glaberrima* has not been studied as extensively as that of *O. sativa*, the Panel recommends exploring more systematically the phenotypic variability of *O. glaberrima* for desirable traits, using sound, up-to-date screening methods, focusing on processes and mechanisms of these traits.
2. To capitalize on the excellent work done on the understanding of the genetic structure of *O. glaberrima*, the Panel recommends that the Genetic Resources Unit, breeders and molecular biologists of WARDA collectively focus on defining core collections of *O. glaberrima*, i.e. collections of accessions representative of the diversity of the whole species.
3. Since the interspecific hybridization sterility problem has been solved, the Panel recommends that WARDA greatly broaden the set of *O. glaberrima* and *O. sativa* accessions used as parents in interspecific hybridizations, using the results of phenotypic and molecular characterizations to ensure larger diversity of parents, monitoring closely the level of introgression and the genetic diversity of the released progenies. The creation of a first generation of interspecific hybrid progenies (NERICAs) should not be seen as the end, but as the beginning of a great "genetic adventure" aimed at making the best possible use of the African gene pools (*O. glaberrima*, *O. sativa* and other species).
4. The Panel recommends that WARDA seek to secure, on a sustainable basis, the funding of INGER-Africa, which is a network essential for the diffusion of genetic progress. The Panel further recommends that INGER-Africa clearly focus on understanding Genotype x Environment interaction patterns across testing sites, and capitalize on the benefits that derive from it.

### Natural resource management

5. The Panel recommends that WARDA: (1) recruit without delay two scientists, in irrigation engineering/hydrology and in crop-water modeling/land use-planning, respectively; (2) develop a strategy to mainstream water management research into the Center's core research program; and (3) help strengthen the capacity of national organizations for conducting research on the rice-water-soil interfaces, in collaboration with IWMI and other relevant partners.
6. The Panel recommends that WARDA develop, in collaboration with weed scientists from advanced research institutions, a strategic vision for future research in weed management,

and revisit its decision to focus almost entirely on the expected weed competitiveness of NERICAs.

### **Quality and relevance of science**

7. In order to improve the priority setting process, the Panel recommends that WARDA collect relevant background information, assign appropriate weights to the constraints identified, focusing only on a few major constraints of regional interest for each rice ecosystem, and better define homogeneous target areas (e.g. through stratification of the biophysical and socio-economic environments).
8. The Panel recommends that WARDA allocate more time and resources to the development of concepts and methodologies, and to understanding genetic and physiological mechanisms and processes responsible for superior performance in the appropriate genetic backgrounds (*O. sativa*, *O. glaberrima*, or NERICAs, according to the situation).
9. In order to ensure that available scientific talent is utilized primarily for science, and in order not to compromise research quality, the Panel recommends that WARDA make every effort to achieve a reasonable balance between in-house scientific activities and external network or partnership activities that focus more on development than on research.

### **Social sciences**

10. Because of research gaps in the social sciences research program (policy analysis, rainfed production economics, adoption studies), the Panel recommends that WARDA recruit a rural sociologist and fill other positions in the social sciences (production economist, policy economist) in a timelier manner.

### **Research support**

11. The Panel recommends that WARDA make the necessary investments and provide funds on a regular basis to ensure communications (e-mail and internet) that meet the performance standards expected at an international research institute, both at its headquarters and outstations.
12. Because good statistical design and analysis is an essential component of research quality, the Panel recommends hiring as soon as possible one full-time biometrician, preferably with good experience in Genotype x Environment interaction analysis, design of on-farm field trials, and analysis of survey data coming from Participatory Varietal Selection.

### **Partnerships and linkages**

13. The Panel recommends that WARDA develop a medium- and long-term strategy for a phased expansion in Central, East and southern Africa, in line with available funds, without compromising critical mass in West Africa. Moreover, the programmatic alignment of WARDA with IRRI in East and southern Africa should specify their respective roles based on their respective comparative advantages.

14. Because the System-Wide Initiative on HIV/AIDS (SWIHA) is not expected to contribute to WARDA's core research outputs, the Panel recommends that WARDA transfer its convening role to a partner more suited to leading the SWIHA initiative.

### **Adoption and impact**

15. Because technology generation must take into account the heterogeneity of the environments and the farming populations, including the different needs of farmers, for better targeting of technologies and better adoption, the Panel recommends that WARDA, in its adoption and impact studies, involve suitable interdisciplinary teams from its research program (breeding, natural resource management, socio-economics).

### **Governance and management**

16. The Panel recommends that the Program Committee augment its resources by relying on an external Board-appointed Scientific Advisory Committee (SAC) comprised of 3-4 outstanding scientists with knowledge of rice and/or other cereals from around the globe, who would provide in-depth guidance on technical quality and strategic directions of science undertaken by WARDA.
  17. The Panel recommends that the Financial Procedures Manual (which was last issued in 2001) be updated and suitably revised, as needed, and that compliance with these procedures be ensured by the Board and Management so that the financial control environment operates as intended.
  18. The Panel recommends that the staff and heads of Corporate Services of WARDA and IITA:  
a) continue a very collaborative approach to ensuring that the transfer/alignment of corporate services proceeds smoothly; b) closely monitor on a regular basis the progress made by the various Transition Task Forces, Steering Committee, and the Local Implementation Committees at Cotonou and other sites covered by the Memorandum of Agreement; and c) seek to benefit from the experience of other Centers that are aligning corporate services. Nevertheless, it cautions WARDA that in seeking efficiency gains from the alignment of corporate services, it ensures that research quality and relevance are not compromised, and that scientists continue to have access to adequate technical support during and after the alignment process.
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## 1. INTRODUCTION, BACKGROUND AND CONTEXT

### 1.1. Africa's rice economy

#### 1.1.1. Rice in the world and in Africa

Rice is the staple food of more than half the world's population, and about four-fifths is produced by small-scale farmers for their own consumption and local markets. According to FAO, about one billion households depend on rice for their livelihood. As a food crop, it is the most consumed cereal. With a growth in demand at a rate of 3.4% per annum (1961-2005), world rice production has been less than rice consumption since 2000, bringing the world's rice stocks to 105 million tons, the lowest level in 25 years. Representing less than two months of global consumption, half of world rice stocks are being held by China.

Global rice consumption and exports are highly concentrated in Asia, which accounts for 88% of consumption and 77% of exports. Compared with the international markets for wheat or maize, which account for some 19% and 13% respectively of world production, the international rice market is "thin" at 28.6 million tons in 2006, or about 7% of global production.<sup>1</sup>

Africa has become a big player in international rice markets, taking up 32% of global imports in 2006, at a record level of 9 million tons that year. Africa's emergence as a big rice importer is explained by the fact that, during the last decade, rice has become the most rapidly growing food source in Sub-Sahara Africa (SSA).<sup>2</sup> Indeed, due to population growth, rising incomes and a shift in consumer preferences in favour of rice, especially in urban areas<sup>3</sup>, the relative growth in demand for rice is faster in SSA than anywhere in the world. This is occurring throughout the sub regions of SSA.

Furthermore, international rice prices have been on an upward trend since early 2003 (see Figure 1.1 below), and it is estimated that if present trends continue, they may double their 2003 level within the next five years. Africa's domestic production is being fueled by this rise, which is reflected in higher producer prices (see Annex VIII). According to OSIRIZ (CIRAD's Observatory of International Rice Statistics), in 2006, Africa cultivated about 9 million hectares of rice, and production, which surpassed 20 million tons for the first time, is expected to increase by 7% per year.

In West Africa, where the rice sector is by far the most important in SSA, the situation is particularly critical. Despite the upward trends in international and domestic rice prices, domestic rice consumption is increasing at a rate of 8% per annum, surpassing domestic rice production growth rates of 6% per annum. The production-consumption gap in this region is being filled by imports, valued at over US\$ 1.4 billion per year. The share of imports in consumption rose from an average of 43% from 1991 to 2000, to an average 57% by 2002-2004.<sup>4,5</sup>

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<sup>1</sup>Calpe, C., International trade in rice: recent developments and prospects, International rice Commission Newsletter, 2005, FAO, Rome, Vol. 54, pp. 11-23.

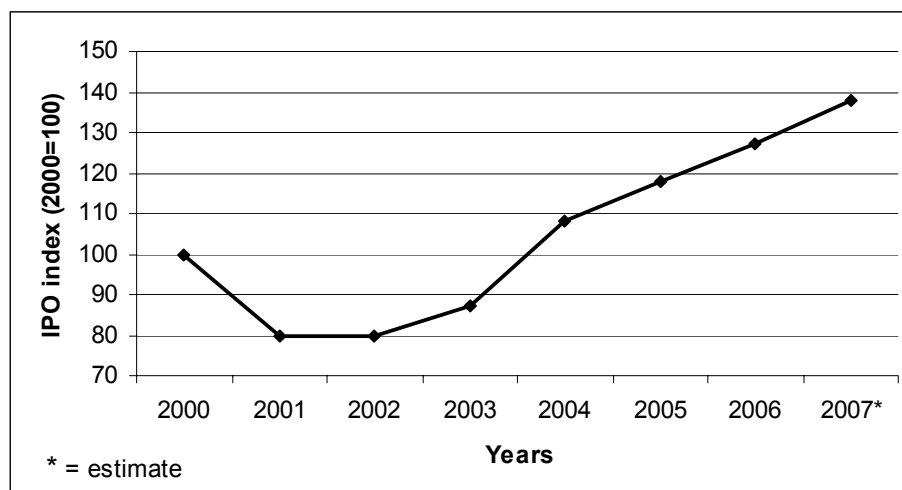
<sup>2</sup>Solh, M., Rice is life in 2004 and beyond, International Rice Commission Newsletter, 2005, FAO, Rome, Vol. 54, pp. 1-10.

<sup>3</sup>Balasubramanian, V., M. Sie, R.J. Hijmans and K. Otsuka, Increasing Rice Production in Sub-Saharan Africa: Challenges and Opportunities, Advances in Agronomy, 2007, Vol. 94, pp. 55-133.

<sup>4</sup>WARDA, Rice Trends in Sub-Saharan Africa, Third Edition, Cotonou, 2005, p. 31 and FAOStat.

Indeed, predictions suggest that imports in West Africa will increase to about 4.5 million tons by 2010 and to anywhere between 6.5 and 10 million tons by 2020.<sup>6</sup>

**Figure 1.1 Evolution of International Rice Prices, 2000-2007 (FOB export basis)**



Source: Osiriz/Infoarroz (various issues) Monthly Report of the World Market of Rice

### 1.1.2. The policy environment of rice in Africa

From an international trade perspective, rice continues to be one of the most protected commodities in both developing and developed countries, through high tariff and non-tariff barriers, export restrictions and aid, state trading and other domestic market interventions. The United States and the European Union heavily subsidize their rice producers, and in doing so depress world rice prices. Asian producers and major exporters such as Thailand, Vietnam, Pakistan and India have national rice strategies for supporting production and sustaining market prices, although they generally do not heavily subsidize rice exports.

While the international policy environment is not favorable to develop rice production in SSA, the rise in international rice prices by 75% since 2003 continues unabated. Furthermore, African producing countries protect local production through import tariffs, quantitative restrictions, and sometimes with subsidies on seeds and fertilizers. The political will to achieve self-sufficiency is there in WCA<sup>7</sup> and ESA, but usually without the needed public investment needed in research, extension, input delivery, credit, irrigation development, markets, etc. In addition, given the order of magnitude of growth in rice consumption, it is clear to the Panel that seeking to eliminate imports over a short time span is unrealistic.

In the case of Nigeria, between 1986 and 1994 there was an import ban, subsidized provision of inputs and finance for production, but none of these measures halted the long-term trend of continuing import-dependency. More recently, the government has announced its intention to

<sup>5</sup> IRRI, Rice Almanac, Third edition, Los Baños, 2002, p. 79.

<sup>6</sup> WARDA, Annual Report 2001-2, p.41.

<sup>7</sup> With some exceptions as tax exempt imports in Guinea and an agreement to subsidize imports.

impose an import ban again.<sup>8</sup> Through the country's Presidential Rice Initiative, which aims at self-sufficiency in rice, producers have been supported by subsidies on seeds (50%) and fertilizers (25%), the legalization of private fertilizer imports, and strong border protection against rice imports – an import duty of 50% and a levy of 50%. As a result, rice production has increased for five consecutive years. However, Nigeria still imported around 1.8 million tons of rice in 2006, despite consumer prices that are among the highest on record due to import protection.<sup>9</sup>

In Guinea (Conakry) where NERICA rice (New Rice for Africa) has so far made the largest impact, domestic production covers about 70% of consumption. In 2006, the country imported 350,000 tons of rice<sup>10</sup>, and now has an agreement between the government and urban labor unions to provide a subsidy on rice imports. This agreement was reached after most rice imports were made tax-free in the last trimester of 2006. In Senegal, rice imports surpassed 600,000 tons in 2006, and according to the international press, the recent riots in Dakar, the capital, were fueled by increasing consumer prices of rice.

### **1.1.3. Poverty, food security and rice**

About one quarter of the world's extreme poor live in SSA, and this share is increasing. Poverty in this region is largely a rural phenomenon, with 80% of the poor in rural areas. Rural poverty reduction must therefore be given priority if the Millennium Development Goals (MDGs) are to be achieved. It has only recently been acknowledged that economic growth can be only truly sustainable when poverty is explicitly taken into account. Therefore, since the great majority of agricultural producers are smallholders, they constitute the engine of income growth in rural areas.

A positive perspective from a recent IFPRI-IITA-CORAF/WECARD and ECOWAS study<sup>11</sup> on regional strategic alternatives for agriculture-led growth and poverty reduction in West Africa noted that "... if countries can maximize their agricultural potential, nine out of twenty West African countries can achieve the 6 % annual agricultural growth target and another seven will attain more than 5% growth in the next 10 years." The study also stated that among the major commodities, rice shows the highest potential for growth, and could subsequently generate the largest producer benefits among many countries and the region as a whole. The study also predicted that "Joint investments in rice research and development at the regional level will provide even higher returns, given its potential for transferability across borders". Furthermore, in CORAF's Strategic Plan (2000), rice was identified as the priority food crop in West Africa's coastal countries, and ranked as the second most important food crop after vegetables in Sahelian West Africa.

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<sup>8</sup> However, these domestic protection measures may not be sustainable in the long term because of its adverse effects on consumer prices.

<sup>9</sup> 2.3 million tons in 2005 according to the FAO Rice Market Monitor of December 2006 (Vol. IX – Issue No 4). Nigeria consumes about 4.5 million tons of rice per year.

<sup>10</sup> Brossier, Jacques, Evaluation of the impact of NERICA rice varieties in Guinée", CCER WARDA, July 2007.

<sup>11</sup> IFPRI in collaboration with IITA, CORAF/WECARD and ECOWAS, Regional Strategic Alternatives for Agriculture-led Growth and Poverty Reduction in West Africa, final draft report, Washington D.C., December 31, 2006.



Rice production and marketing has large multiplier effects, with many forward and backward linkages throughout the economy, producing a large value surplus, leading to wealth accumulation (savings), which can be the source of new investments, increasing (land and labor) productivities, resulting in a continued process of positive cumulative change in the economy and people's living conditions. The conclusion is that rice development is potentially the best driver of development for SSA – the locomotive that will enable growth and poverty reduction. In addition, WARDA is in the driver's seat of such development. The fact that prices to producers in Africa are rising provides new incentives for technological change, and constitutes an opportunity that WARDA should not miss.

#### 1.1.4. Rice production and productivity, quality, and local institutions

While in the ESA region, rice is very much a cash crop for small- to medium-scale farmers, it is more of a subsistence crop in West Africa, where most of the continent's rice is produced. In West Africa, 75% of the total production of rice in 1999/2003 is from upland, hydromorphic and lowland ecosystems, with about 25% from irrigated fields (see Table 1.1). Rice is also produced in mangrove production systems and in flooded environments.<sup>12</sup>

Yields constitute one of the main challenges of rice production in SSA. The gap between potential yields and actual yields is usually large, for a variety of reasons (discussed further in this report). Furthermore, in spite of their rise in more recent years, average rice yields in SSA have been, overall, decreasing since the mid-1990s. The more recent increases are mainly due to the expansion of rice production into marginal areas in West Africa, where most production occurs (see Figure 1.2, below).

<b>Table 1.1 Estimation of rice production trend by each rice production ecology in West Africa during 1984 and 1999/2003</b>						
	<b>Area ( million ha)</b>		<b>Production (million t/year)</b>		<b>Yield (t/ha)</b>	
	<b>1984</b>	<b>1999/2003</b>	<b>1984</b>	<b>1999/2003</b>	<b>1984</b>	<b>1999/2003</b>
Upland	1.5	1.8	1.5	1.8	1	1
Rainfed lowland	1.5	1.8	0.75	3.4	1.4	2.0
Irrigated lowland	0.23	0.56	0.64	1.9	2.8	3.4
Total	2.6	4.7	3.4	7.7	1.3	1.6

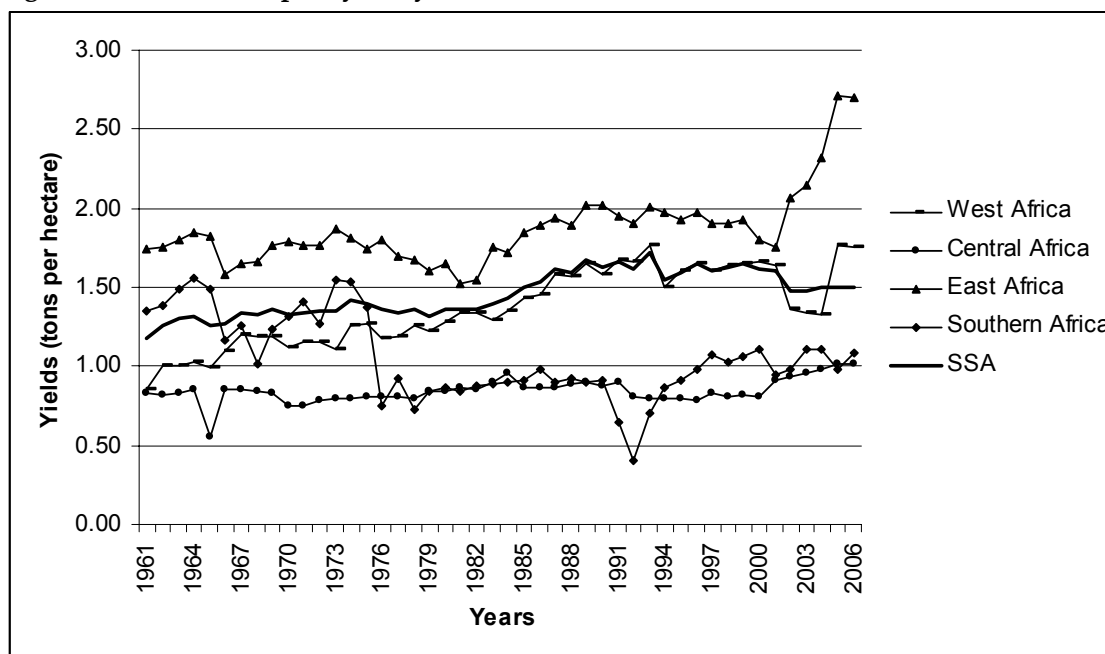
Source: CCER on Integrated Genetic and Natural Resources Management, Gurdev Kush, Toshiyuki Wakatsuki and Glitho Isabelle Adole, 22 January-10 February 2006, WARDA, Cotonou.

Another challenge is the inferior quality of domestic rice *vis a vis* imported rice. Domestic rice is of uneven quality, has impurities, and is usually sold in bulk, in 5kg bags, unbranded, at a discount of 30% to 50%, compared to imported rice. There are exceptions to this, as in Guinea (Conakry) and in Mali, where local rice (for certain varieties) receives a price premium. In order to improve quality of local rice, institutional innovations are needed that make producers more

<sup>12</sup> Research on the mangrove ecology is coordinated by the Rokupr rice research station in Sierra Leone with financial support from WARDA.

responsive to end-user requirements, and attach much more importance to milling and cleaning, and identity preservation (no mixing of different rice varieties).

**Figure 1.2 Evolution of paddy rice yields in Sub-Saharan Africa (1961-2006)**



Source: Alioune Diagne, 2007, personal communication, WARDA.

The institutional environment for the development of rice production in SSA represents a third challenge. It is gradually improving as a result of NEPAD's<sup>13</sup> focus on agriculture with the CAADP<sup>14</sup>, the African Rice Initiative (ARI), and efforts by WARDA and its many partners, particularly its Council of Ministers (COM). However, national institutions efforts to support rice production and post-harvest are almost always insufficient. Many village associations belong to the village community as a whole, have no formal association status, often have no formal accounting system, and entirely depend on the credibility of their leaders. It is thus not surprising that many fail while others are purely political organizations capturing resources through political networks. It is thus unrealistic to expect them to perform effectively as farmer-owned businesses. Cooperatives, when they are established, have to be coherent with pre-existing hierarchical social structures. Many of them lack business orientation and responsiveness to the members. How to create and support effective institutions is a major challenge.

The truth of the matter is that in SSA, growth in rice demand as a preferred staple is so strong that production intensification and higher yields per hectare will not be sufficient to fill the gap and meet rice demand. Unlike in Asia during the green revolution, productivity gains are likely to come in small increments due to the diverse nature of Africa's cropping systems.<sup>15</sup> Yet the potential for growth in the African rice sector is enormous. A rapid increase in the area under

<sup>13</sup> New Partnership for Africa's Development

<sup>14</sup> Comprehensive Africa Agricultural Development Programme

<sup>15</sup> Balasubramanian, V., M. Sie, R.J. Hijmans and K. Otsuka, Increasing Rice Production in Sub-Saharan Africa: Challenges and Opportunities, *Advances in Agronomy*, 2007, Vol. 94, pp. 55-133.

rice, irrigated as well as rainfed, is necessary. In particular, the development of new irrigated rice schemes is vital. Only about 17% of the rice area in Africa is irrigated. Asia, in contrast, has about 57% of the rice area under irrigation, but has little or no room for further expansion. Indeed, Ram C. Chaudhary and Dat Van Tran<sup>16</sup> seriously consider whether Africa can be the future rice bowl of Asia. By 2010, Asia may no longer have net rice exports, because of increasing population and consumption, and decreasing land, labor, water and other resources. Instead, by 2020, it is expected that Asia may become a rice-importing continent. They state that millions of hectares of land appropriate for rice growing lay idle in Africa. Water and other resources are available and plentiful. They add that there are other comparative advantages of Africa, which can complement Asian strengths. In addition, they argue that Asia-Africa cooperation in rice production can convert many African countries from net rice importers to net rice exporters, as well as provide hope for Asian countries to fill their rice bowl.

## **1.2. WARDA's mission and as a research for development institution**

WARDA was created in 1970 by 17 member countries as a rice development association in West Africa before it joined the CGIAR in 1987. While it is a CGIAR research Center, development activities have always been prominent at WARDA because of its origins and association status – governed by a Council of Ministers (COM) of 17 West African countries. Moreover, the *modus operandi* of WARDA, as the smallest of all CGIAR Centers in terms of budget, is collaborating with NARS and stakeholders at all levels.

WARDA's challenges in rice productivity, rice quality and post-harvest, and rice institutions are certainly daunting. WARDA's mission statement has evolved over the years in response to these challenges, and to developments in the CGIAR and its member states. WARDA's mission for the period 2003-2012 is *to contribute to poverty alleviation and food security in Africa, through research, development and partnership activities aimed at increasing the productivity and profitability of the rice sector in ways that it ensures the sustainability of the farming environment*. Key aspects contained in this mission are the goals, the strategy through which these goals will be achieved, and WARDA's objectives, including the focus on attaining sustainable rice production and contributing to the achievement of the MDGs. The Panel is of the opinion that the need for rice and for research on improving its productivity and supply remains high in SSA (as discussed above), and that WARDA's mission remains relevant and appropriate.

Presently, development activities of WARDA occur mainly through networks operated through its technology transfer unit, rice policy dialogue in Africa, through APRAG and through the Africa Rice Initiative (ARI), which promotes the production and diffusion of quality seed, particularly of NERICAs.

WARDA varieties have not been adopted as widely as hoped for. WARDA has therefore tended to move more towards the development side of the research and development continuum, especially concerning foundation seed production in the ARI<sup>17</sup> framework, given the lack of sufficient private sector activities in seed production in West Africa. Thus, WARDA, like any

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<sup>16</sup> Ram C. Chaudhary and Dat Van Tran, Can Africa be the Future Rice Bowl for Asia?, in Proceedings of the 4<sup>th</sup> Asian International Rice Conference, Cebu, the Philippines, 1999, 29 p.

<sup>17</sup> Presently, 100 tons of NERICA foundation seed are being produced by WARDA at M'bé for Nigeria in the framework of Nigeria's Presidential Rice Initiative.

other commodity-based CGIAR Centers operating in SSA, struggles with the issue of how far to go in (foundation) seed production.

### **1.3. The general organization of WARDA**

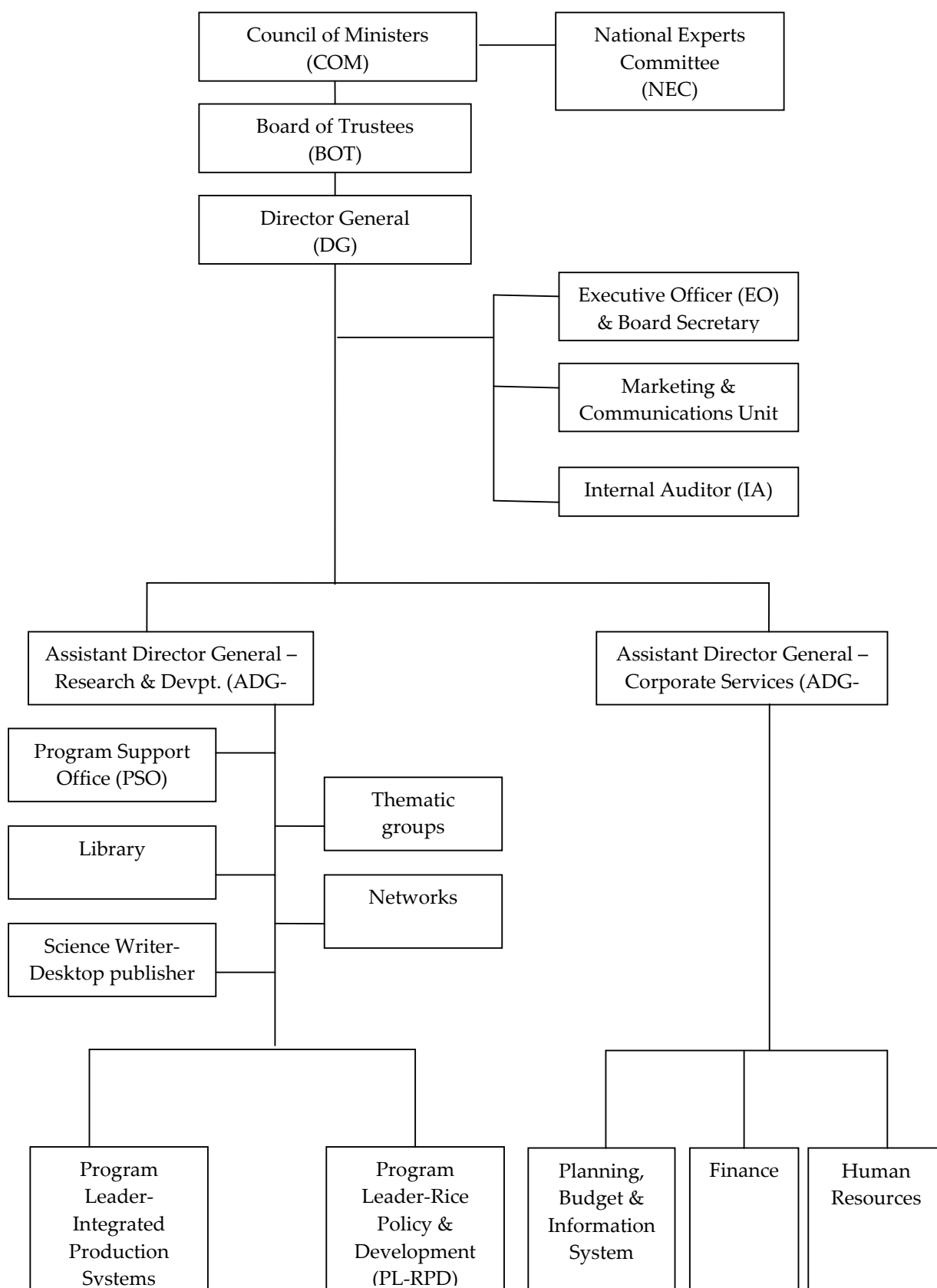
In response to external and internal developments, the organizational structure of WARDA has changed several times since the 4<sup>th</sup> EPMR. The new Director General established a new organizational structure at WARDA in 2007, as shown below, in Figure 1.3. The division between a research and development department and a corporate services department, both headed by an Adjunct Director General, seems to be working well. To the Panel, this organizational structure appears functional and adequate.

### **1.4. The “Ivorian crisis”**

During the review period, a major determinant of WARDA’s programme was the “Ivorian crisis”. In September 2002, WARDA was suddenly confronted with a huge external shock that has had significant long-lasting after-effects. A *coup* attempt by rebel forces in Côte d’Ivoire, centered initially around Bouaké, WARDA’s permanent headquarters, necessitated a hurried mass evacuation of all staff and families to safer ground in Abidjan and Bamako (in Mali). Center management and staff showed commendable resourcefulness and fortitude; and were able to retrieve most of the germplasm collections and important documents and data, thus maintaining many essential functions. Despite their heroic efforts, and the financial assistance and moral support from WARDA’s investors and partners, Center operations were inevitably, severely disrupted, and staff and families had to face considerable professional challenges and personal hardship during this harrowing period.

In May 2003, the opposing forces in Cote d’Ivoire signed a Peace Agreement, which promised an immediate end to hostilities. Encouraged by this, the Board and Management of WARDA initiated plans to return to Bouaké. Upon receiving assurances from national and local authorities, a partial return to the headquarters in M’bé was attempted in September 2004. However, this attempt was interrupted by a resumption of hostilities around Bouaké, including the tragic loss of life of one WARDA senior staff member. This meant a second retreat from Côte d’Ivoire, and the relocation of WARDA to its current temporary headquarters in Cotonou, Benin.

**Figure 1.3 Organizational structure – Africa Rice Center**



The Center's headquarters and most of its staff have thus been located in Cotonou since January 2005. In April 2005, the WARDA Board and Management assessed the evolving situation in Côte d'Ivoire. In view of the continuing uncertainty and unpredictability of the ground realities in Bouaké, and in order to provide stability to the work program, staff, and families, they came to the conclusion that the return to M'bé could take between 3-5 years, if not more. Thus at the time of this EPMR, five years after the first eruption of the "Ivorian crisis", WARDA is still awaiting a return of stable peace in Côte d'Ivoire.

The main events of the "Ivorian crisis" are further described in Annex IX. The severe continuing effects of this crisis on WARDA's research program, governance, and management are discussed in the main text. In the Panel's view, the Center has now largely--but not wholly--recovered from the effects of this "Ivorian crisis", as discussed in relevant sections of this report.

### **1.5. Key developments since the fourth EPMR<sup>18</sup>**

#### **1.5.1. Institutional developments**

In March 2001, WARDA completed its Phase II Construction (Phase II) at its headquarters in M'bé, Côte d'Ivoire. Phase II included two main buildings: the Information and Documentation Center (IDC) hosting offices, a computerized library and the conference hall; and the Research Extension Building hosting offices and fully equipped laboratories for grain quality and physiology, pathology and agronomy. This development was fully funded through Member states' contributions.

In September 2002, WARDA completed the construction of a fully equipped biosafety building at M'bé, Côte d'Ivoire. Genebank facilities were also under construction, but this was not carried through because of the "Ivorian crisis". The "Ivorian crisis" in 2002-2004 caused serious disruption and resulted in a financial loss for WARDA. Many staff left and had to be replaced. In September 2006, WARDA completed the construction of a fully equipped genebank at the IITA-Benin Station in Cotonou where it has established its temporary headquarters. The materials and equipment were retrieved from M'bé.

WARDA has taken a more prominent role in Eastern and Central Africa, providing backstopping and financing for the newly established Eastern and Central Africa Rice Research Network (ECARRN) created by the Association for Strengthening Agricultural Research in Eastern & Central Africa (ASARECA).

WARDA is swiftly moving towards achieving gender balance: from no female senior staff at the time of the 4<sup>th</sup> EPMR to nine women employed in senior positions, including two in the Senior Management Team (SMT).

#### **1.5.2. Governance**

The number of Board members was reduced, in line with CGIAR guidelines. Throughout the period under review, the Board and the COM provided an element of stability to WARDA, its management and staff, and helped weather the disruption caused by the "Ivorian crisis".

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<sup>18</sup> The Panel's comments on WARDA's follow-up actions on the 4<sup>th</sup> EPMR recommendations are presented in Annex VII.

### **1.5.3. Programmatic developments**

Several reorganizations in program structure took place following the 4<sup>th</sup> EPMR recommendations. WARDA published a new Strategic Plan 2003-2012 (SP) in 2004, preceded by a priority-setting exercise and extensive consultations and planning meetings over a period of three years. Two core research areas were defined in the SP: integrated rice production systems, and rice policy and development. Each program comprises several projects, partnerships and network activities.

Several rolling Medium-Term Plans (MTP) were also prepared to guide WARDA's research. An internal priority-setting task force helped prepare the 2005-2007 MTP. The number of projects was reduced from 14 in the 2004-2006 MTP to eight in the 2005-2007 MTP, and to six in the proposed 2008-2010 MTP. The consolidation aims to simplify WARDA's research program structure. As a result of the "Ivorian crisis", the Centre experienced a large turnover of IRS and GSS<sup>19</sup> support staff, with several senior experienced scientists leaving WARDA. Actual staff numbers have recovered and are now comparable to those at the time of the 4<sup>th</sup> EPMR, indicating a rapid build-up of staff capacity in recent years.

### **1.5.4. Financial management**

Despite the crisis that erupted in Côte d'Ivoire in September 2002 and the subsequent temporary relocations of the Center's headquarters, WARDA has grown from a position of chronic deficit to positive reserves, to cover 87 days at the end of 2005, and 105 days at the end of 2006. WARDA's budget remained more or less stable around US\$ 10-11 million over the period under review. A further indicator of financial health is the Center's efficiency of operations expressed as a ratio between indirect and direct costs. For 2006, the indirect/direct cost ratio is projected at 28%, slightly above the CGIAR average.

### **1.5.5. Communication and public awareness**

On 2<sup>nd</sup> September 2001, to commemorate WARDA's 30th anniversary, a new corporate website was launched in English and French, with a stronger focus on research and partnerships. Besides its new look and design, it has several new features and components. A new website for the ECARRN was also developed. The ARI and IVC sites were revamped, and the SWIHA site was restructured.

## **1.6. Evolution of WARDA: strategic and medium term plans, research program structure, research organization by location, CGIAR system priorities**

### **1.6.1. The strategic plan**

A strategic plan (SP) was prepared in 2001-2003, and covers the period 2003-2012<sup>20</sup>. A priority-setting exercise preceded the elaboration of the SP. This is discussed in the section on relevance

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<sup>19</sup> IRS = Internationally-recruited staff; GSS= General support service staff.

<sup>20</sup> WARDA, Strategic plan 2003-2012, 2004 and Achievements since the Fourth External Program and Management Review, 2007, 32 p.

and quality of science. It recognized three rice ecologies in a continuum as a major focus of WARDA research: rainfed upland, rainfed lowland, irrigated.

### 1.6.2. The Medium Term Plans

WARDA develops the standard CGIAR required documents such as regular three-year rolling MTPs<sup>21</sup>, which permits WARDA to adapt its research to agricultural changes in Africa and the evolution of world rice research. The MTPs<sup>22</sup> are plans of work and indicate how WARDA's research activities fit within the CGIAR's system priorities, the type of international public goods to be developed, and what impact pathways are followed. They list projects with the expected activities and outputs, and the breakdown of the budget among projects. They are prepared annually and submitted to the Science Council for review, and commentary and subsequently to the Executive Committee of the CGIAR for approval.

As part of the ongoing CGIAR Centre alignment process, regional MTP's have also been prepared. WARDA was assigned to lead the process in WCA (refers to SC issue 15). In the regional MTP, five programs are defined, using the system priorities as the organizing principle. In total, 13 CGIAR Centers participated in the preparation of the WCA MTP, together with CORAF/WECARD, NARS scientists, policy makers and NGOs.

More important than the form of MTPs is the content. WARDA tries to cover too much ground with too little resources. For example, WARDA intends to extend its activity geographically to East and Central Africa. The Institute has broadened its research topics to include in its project portfolio a systemwide initiative on HIV/AIDS in agriculture that looks, at best, very remotely linked to WARDA's core mission (see above). WARDA has already extended its activity relatively far towards development, with its involvement in ARI. With the present human resources, WARDA cannot reasonably stretch in all these directions (geographic, thematic and research continuum), and remain effective and efficient. WARDA's management should adopt a more cautious approach towards such dispersion. Above a given threshold, the risk is a lowering in research quality and an over-exploitation of existing human resources who are already arguably over-stretched. Increase in activity should only be envisioned once additional and sustainable resources are secured.

The 4<sup>th</sup> EPMR had already cautioned WARDA on the danger of a rapid geographic expansion. The same can be said for thematic expansion. *The Panel cautions WARDA to only extend its thematic activities in rice and in areas where it has an obvious comparative advantage, and only after it has secured the needed human and financial resources. This is further elaborated in Chapter 4 on partnerships and linkages.*

A previous EU funded review indicated that the quality of the 2002-2004 MTP was insufficient.<sup>23</sup> In the Panel's opinion, the MTP covering the years 2007-2009 was on par with other Center MTPs the Panel had access to. The Panel appreciated the efforts made to spell out the pathways to

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<sup>21</sup> WARDA, Achievements since the Fourth External Program and Management review, 2007, 32 p.

<sup>22</sup> WARDA, Medium Term Plan 2007-2009, Charting the future of rice in Africa, 2006, 141 p.

<sup>23</sup> Ahmadi, Nourollah and Alastair William Orr, Creating Low Management Plant Types for Resource-Poor Farmers in Rainfed Ecosystems Project, WARDA, Monitoring of CGIAR Projects Co-funded by the European Commission in 2003 in Asia, Latin America and the Mediterranean Regions, ECART-NATURA, Brussels, December 2004, 21 p. + annexes.



impact in the project portfolio, but felt they could sometimes be more precise. A global imprecision on the expected outputs and an underestimation of the time needed to deliver them is also observed. The Panel, however, acknowledges the fact that the impact of research is something over which the Center has limited control.

### **1.6.3. The research structure**

There were four research programs in 2000, 3 in 2004, 2 from 2005 on. There were 19 projects in 2004, and only 6 in 2007 plus the IVC, a systemwide program (SWIHA) and partnerships. The Research Program structure is now as follows, as shown in Figure 1.4:

Presently, under Program 1, there are three projects, as follows:

- Project 1: Enhancing productivity and stability of upland rice-based systems
- Project 2: Sustainable intensification of lowland rice-based systems for enhanced livelihoods
- Project 3: Enhancing the performance of irrigated rice-based systems in Africa

Under Program 2, there are also three projects:

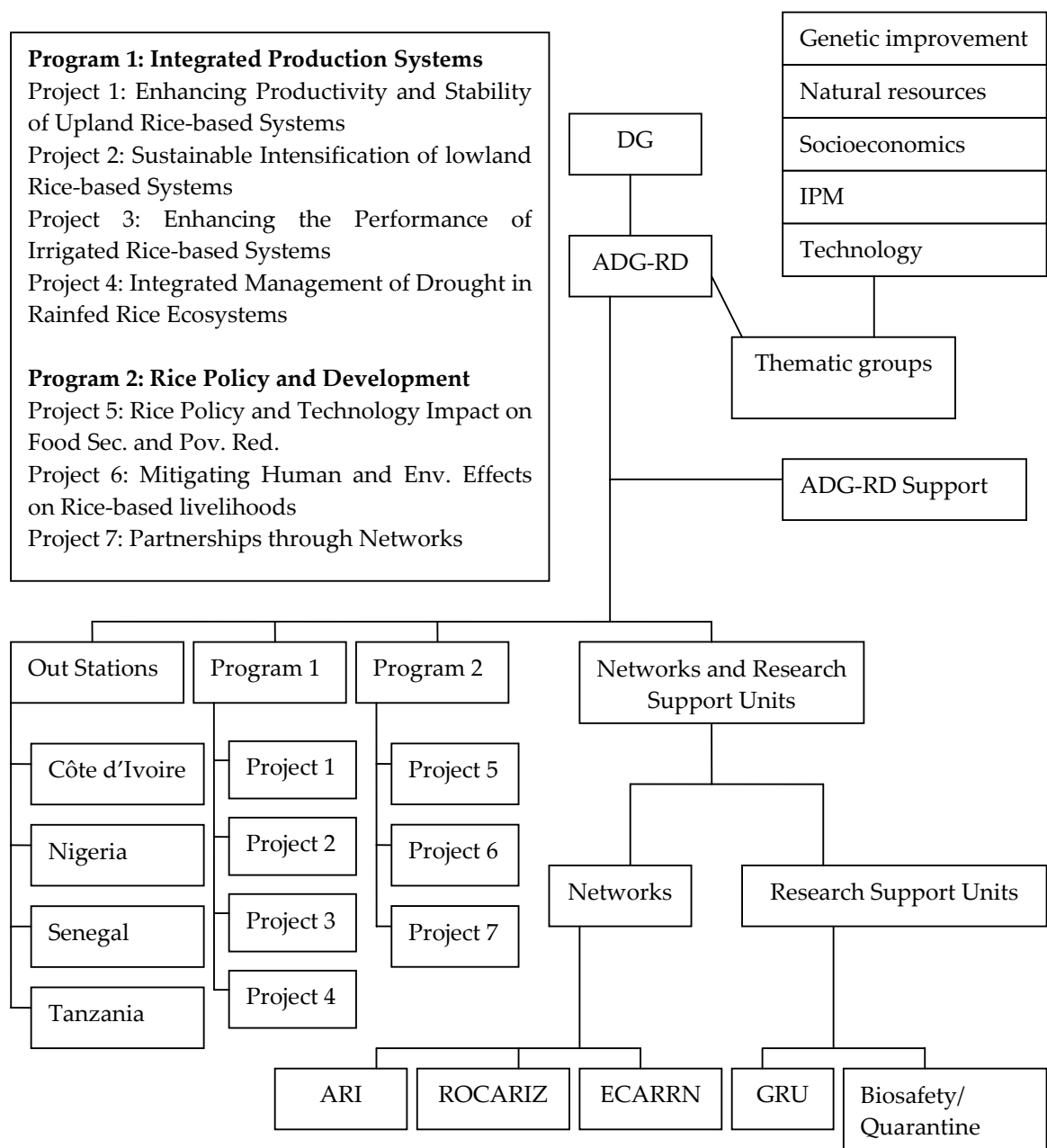
- Project 4: Rice policy and technology impact on food security and poverty reduction
- Project 5: Adaptation to human and environmental effects of rice-based livelihoods
- Project 6: Partnerships, learning and innovation systems

In addition, there are:

- The Consortium for the Sustainable Development of Inland Valley Agro-ecosystems in Sub-Saharan Africa (IVC) (previously this was called Project 7)
- Systemwide Initiative on HIV/AIDS and Agriculture (SWIHA)

In the 2008-2010 MTP, Project 4 in Program 1 on drought in rainfed ecosystems has been merged with Projects 1 and 2. There are also five disciplinary Thematic groups that cut across these projects, as follows: genetic improvement, natural resources, socioeconomics, integrated pest management and technology transfer.

Figure 1.4 The Structure of the Research Programs



A Program Leader who is responsible for several projects leads the two Programs. The Panel understands that grouping the various projects under two Programs is expected to simplify the lines of communication and accountability, and to help provide clearer strategic direction and a sharper focus on the relevance of research undertaken at WARDA. The proposed Thematic groups, if properly implemented, are expected to help focus attention on the scientific disciplines that must underpin high-quality research products. The Panel was also informed that the current Program Leaders have been appointed to these Thematic leadership positions for the first year. In following years, the Program Leaders are expected to be elected by the scientists themselves, though based on criteria specified by Management. The Program leaders are expected to devote about 80% of their time to research, and 20% to program administration and other institutional tasks.

The Panel has several concerns regarding this research structure. For a small institute with only about 30 IRS engaged in research and only 6 research projects (i.e., excluding the IRS in corporate services and management), it is not clear that the additional administrative layer of “Program Leader” between the ADG Research and the Project Coordinators is really needed. The Panel is concerned that this layer may add to communication and supervision difficulties, especially since the administrative tasks to be undertaken by Program Leaders are expected to require only 20% of their time. *We therefore suggest that the need for Program Leaders be reconsidered at the end of the first year of the ongoing “trial” period, and Management take a decision on whether new Program Leaders then need to be appointed.*

If management decides to maintain the two Program Leader positions, these leaders are expected to be selected by the scientists themselves. Rather than leaving such decisions to Program scientists, *the Panel suggests that Program Leaders are appointed by the DG and ADG (R&D) based on a thorough evaluation of past performance as a project coordinator or Program Leader.* The assessment criteria would need to include such aspects as talent/potential for managing scientific and financial resources and outputs, mobilizing funds for projects, representing the Research Program and WARDA to external stakeholders and donors, and collaborating with NARS and other partners.

In addition, the Panel is concerned that the proposed Thematic groups are expected to function primarily as “virtual” teams on an *ad hoc* basis, for example to review publications and organize seminars. This may not be sufficient to strengthen the scientific quality of research at WARDA. To address this potential problem, *the Panel suggests that Thematic Group Leaders be given formal authority to monitor, on an ongoing basis, the quality of research inputs provided by scientists to their project(s), and to participate in their annual performance assessments as senior peer reviewers.*

#### 1.6.4. The research organization by location

The research staff is spread over several locations as shown in Table 1.2, below:

<b>Location</b>	<b>IRS</b>	<b>Visit. Sc./ consultants</b>	<b>Res. assistants</b>	<b>Res./lab technicians</b>	<b>Field assistants</b>	<b>Research support</b>	<b>Total</b>
<b>Cotonou/M'bé</b>	29	3	20	17	10	14	93
<b>Samanko/Mali</b>	1		1				2
<b>St. Louis / Senegal</b>	5	1	5	2	6	7	26
<b>Ibadan/Nigeria</b>	5		1	1	9	4	20
<b>ECARRN</b>	1	1		1		2	5
<b>M'bé</b>	1			1	10	24	36
<b>Total</b>	42	5	27	22	35	51	182

Staffing in the different stations/locations of WARDA is discussed under research programs and in research support.

#### 1.6.5. Addressing CGIAR system priorities

WARDA's resource allocation to the various CGIAR System Priorities is detailed in Table 1.3. Three areas are strongly addressed by WARDA, and get the highest budget shares (around US\$ 3.0 million each): Priority area 2 (Producing more and better food at lower cost through genetic improvement), with US\$ 3.3 million; Priority area 5 (Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger), with US\$ 3.20 million; and Priority area 4 (Poverty alleviation and sustainable management of water, land, and forest resources), with US\$ 3.12 M. Priority area 1 (Sustaining biodiversity for current and future generations) is getting US\$ 1.42 million. Priority area 3 (Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products) is receiving US\$ 0.45 million.

The importance given to the various priorities is generally that expected from a Center focusing on a staple crop, which gives importance to the use of genetic resources, rather than to their pure conservation. WARDA is working in most rice growing ecosystems of Africa, including the less favorable uplands where most of the poor are located. WARDA is, nevertheless, paying attention to diversification, through research done in the IVC. Whatever the rice ecosystem, production systems include other crops. Therefore, rice production systems have to be studied in their totality. This does not seem detrimental to WARDA's core focus on rice. The division of resources among CGIAR System Priorities corresponds well to WARDA's mandate and, therefore, seems about right to the Panel.

Table 1.3 WARDA's resource allocation by CGIAR system priorities (US\$ million)								
WARDA's projects	P1	P2	P3	P4	P5	P6	IVC	N*
<b>Priority area 1: Sustaining biodiversity for current and future generations</b>								
Priority 1A: Conservation and characterization of staple crops	0.09	0.35	0.08	0.07	-	0.07	-	0.22
Priority 1B: Promoting conservation and characterization of under-utilized plant genetic resources to increase the income of the poor	0.08	0.33	-	0.08	-	0.07	-	-
Priority 1C: Conservation of indigenous livestock	-	-	-	-	-	-	-	-
Priority 1D: Conservation of aquatic animal genetic resources	-	-	-	-	-	-	-	-
<b>Priority area 2: Producing more and better food at lower cost through genetic improvements</b>								
Priority 2A: Maintaining and enhancing yields and yield potential of food staples	0.53	0.35	0.38	0.13	-	-	0.02	0.62
Priority 2B: Tolerance to selected abiotic stresses	0.25	0.42	0.25	0.07	-	-	0.02	-
Priority 2C: Enhancing nutritional quality and safety	0.08	0.14	-	0.07	-	-	-	-
Priority 2D: Genetic enhancement of selected high-values species	-	-	-	-	-	-	-	-
<b>Priority area 3: Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products</b>								
Priority 3A: Increasing income from fruit and vegetables	-	0.14	0.03	-	0.03	-	0.06	-
Priority 3B: Income increases from livestock	-	-	-	-	-	-	0.02	-
Priority 3C: Enhancing income through increased productivity of fisheries and aquaculture	-	-	-	-	-	-	0.17	-
Priority 3D: Sustainable income generation from forests and trees	-	-	-	-	-	-	-	-
<b>Priority area 4: Poverty alleviation and sustainable management of water, land, and forest resources</b>								
Priority 4A: Integrated land, water and forest management at landscape level	0.08	-	0.25	-	0.07	0.07	0.40	-
Priority 4B: Sustaining and managing aquatic ecosystems for food and livelihoods	-	0.09	0.10	-	-	0.16	0.26	-
Priority 4C: Improving water productivity	-	-	0.10	-	0.05	-	-	-
Priority 4D: Sustainable agro-ecological intensification in low- and high-potential	0.17	0.14	0.18	0.25	0.08	0.04	0.28	0.44

Table 1.3 WARDA's resource allocation by CGIAR system priorities (US\$ million)								
WARDA's projects	P1	P2	P3	P4	P5	P6	IVC	N*
areas								
<b>Priority area 5: Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger</b>								
Priority 5A: Science and technology policies and institutions	-	-	0.10	-	0.08	0.11	-	-
Priority 5B: Making international and domestic markets work for the poor	-	-	-	-	0.15	0.04	-	-
Priority 5C: Rural institutions and their governance	-	-	-	-	0.15	0.22	-	-
Priority 5D: Improving research and development options to reduce rural poverty and vulnerability	0.25	0.14	0.05	0.19	0.15	0.22	0.30	0.65
<b>TOTAL</b>	<b>1.50</b>	<b>2.10</b>	<b>1.50</b>	<b>0.90</b>	<b>0.80</b>	<b>0.70</b>	<b>2.20</b>	<b>1.70</b>

\* N= networks; SWIHA project not included in the Table.

Source: 2007-2009 MTP, WARDA.

## 2. RESEARCH PROGRAM

WARDA has two Research Programs, each with several projects (see section 1.6.3 on Research program structure). The Panel's assessment of research activities was conducted on a disciplinary basis to focus on science relevance and quality.

### 2.1. Rice genetic improvement

#### 2.1.1. Brief history of rice genetic improvement at WARDA

WARDA, as all crop-based CGIAR Centers, gives central importance to plant genetic improvement. WARDA has had ongoing breeding activities since its creation in 1971. The work initially covered all ecosystems. In 1987, WARDA became a member of the CGIAR, and moved from Liberia to Côte d'Ivoire. WARDA abandoned its work on mangrove and deep water ecosystems to focus on the upland-rainfed lowland-irrigated continuum that presently represents 87% of the rice area and around 89% of rice production in Africa. The irrigated rice-breeding program, originally set at Richard Toll, is based in N'diaye near St. Louis, Senegal, since 1990. The rainfed lowland program, which was relocated from IITA to Côte d'Ivoire in 1991, together with the upland breeding program were based in Côte d'Ivoire up to the civil unrest of 2002. Both rainfed lowland and upland rice breeding programs are now conducted from Cotonou, after a short passage through Mali between 2002 and 2004. WARDA's target area was initially West and Central Africa (WCA), but is now in the process of being extended to the whole of SSA.

After an initial focus on *Oryza sativa*, WARDA decided in the early 1990s, to exploit the African cultivated gene pool (*O. glaberrima*) seen as complementary to the Asian cultivated gene pool (*O. sativa*). The Center chose to concentrate on interspecific hybridization between *O. sativa* and *O. glaberrima*. Several attempts to produce such interspecific hybrids had been made in the past, but WARDA's breeders deserve credit for having persevered in this domain despite the difficulties, and for solving the sterility problems. These interspecific progenies developed for the uplands were called NERICAs (New Rices for Africa). In 1996, WARDA adopted Participatory Varietal Selection (PVS) to improve NERICA dissemination. The first upland NERICAs were released in 2000. In 2002, the African Rice Initiative (ARI) aiming at large diffusion and seed production of the new varieties was launched. The NERICA program, initially targeting the uplands, was then, extended to include the rainfed lowland ecosystem, then the irrigated ecosystem. The first lowland NERICAs were released in 2005, the first irrigated ones in 2007. There are now 81 varieties named NERICA<sup>24</sup>, all target ecologies combined.

#### 2.1.2. Genetic resources

In West Africa, most of the cultivated rice varieties belong to the *O. sativa* species, the Asian cultivated rice species. Farmers also grow some *O. glaberrima*, the African cultivated species,

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<sup>24</sup> Rodenburg J, Diagne A, Oikeh S, Fukatuchi K, Kormawa PM, Selon M, Akintayo I, Cissé B, Sié M, Narteh L, Nwilene F, Diatta S, Sere Y, Ndjondjop MN, Youm O, Keya SO, Achievements and impact of NERICA on sustainable rice production in sub-Saharan Africa, 2006, International Rice Commission Newsletter, 55:45-58.

either as pure stand or as mixture of *O. sativa* and *O. glaberrima*.<sup>25</sup> Despite several positive features (see section 2.1.2.1), *O. glaberrima* has regressed since the introduction of *O. sativa* in Africa between the 15th and 17th centuries<sup>26</sup>, because of its poorer yield potential and higher shattering compared to *O. sativa*. This progressive demise justified the collections that have been made in the 80s, notably by IRD (ex-ORSTOM) to preserve the African material. *O. glaberrima* varieties represented 15% of the number of cultivated accessions in a survey conducted in upland villages of Guinea in 2005<sup>27</sup>, but more precise estimates in terms of area are apparently not available. Wild types are easily encountered in Africa. They belong mostly to *O. barthii* (the direct ancestor of *O. glaberrima*), or to *O. longistaminata*, the species with the widest distribution on the African continent. Hybrids between the various species have long been considered as difficult to produce.<sup>28</sup>

The varietal situation is reflected in the composition of the accessions stored by WARDA's Genetic Resources Unite (GRU) (see also section 2.6.2). Because of the strong focus of WARDA these last years on *O. sativa* x *O. glaberrima* interspecific hybrids, the Panel paid an attentive look at the way the diversity of *O. glaberrima*, that has not yet been explored as much as that of *O. sativa*, was assessed.

### 2.1.2.1. Exploration of the diversity of *O. glaberrima*

#### Phenotypic variability

Two *O. glaberrima* ecotypes have been distinguished in the past: an "erect" type and a "floating" type corresponding to accessions grown in the upland and the lowland ecosystems respectively.<sup>29</sup> The erect type is also characterized by a gradient of growth duration.<sup>30</sup>

Most *O. glaberrima* accessions possess interesting characteristics: Early vegetative vigor due to fast germination, droopy early leaves with high specific leaf area, and high tillering ability that translates in good weed competitiveness, resistance to African insect pests notably the African rice gall midge, and, more recently demonstrated for a few accessions, resistance to dangerous soil nematodes such as *Meloidogyne graminicola*, a serious pest in upland fields, resistance to the rice yellow mottle virus, and high protein content.

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<sup>25</sup> Barry MB, Pham J-L, Noyer J-L, Billot C, Courtois B, Ahmadi A, Genetic diversity of the two cultivated rice species (*O. sativa* and *O. glaberrima*) in Maritime Guinea. Evidence of interspecific recombination, 2007, Euphytica 154 (1-2): 127-137.

<sup>26</sup> Pham J., Evaluation des ressources génétiques des riz cultivés en Afrique par hybridation intra- et interspécifique, 1992, PhD thesis, Université de Paris XI, Orsay, Paris.

<sup>27</sup> Barry MB, Pham J-L, Noyer J-L, Courtois B, Billot C, Ahmadi N., Implications for in situ genetic resource conservation from the ecogeographical distribution of rice genetic diversity in Maritime Guinea. Plant Genetic Resources: Characterization and Utilisation, 2007, 5(1): 45-54.

<sup>28</sup> WARDA, Achievements since the Fourth External Program and Management Review, 2007, Cotonou, internal document, 32p.

<sup>29</sup> Portères R., Taxonomie agrobotanique des riz cultivés *O. sativa* L. et *O. glaberrima* Steud, 1956, Journal d'Agriculture Tropicale et de Botanique Appliquées  
Second G., Relations évolutives chez le genre *Oryza* et processus de domestication, 1984, PhD thesis, Université de Paris XI, Orsay.

<sup>30</sup> Barry MB, Pham J-L, Noyer J-L, Billot C, Courtois B, Ahmadi A, Genetic diversity of the two cultivated rice species (*O. sativa* and *O. glaberrima*) in Maritime Guinea. Evidence of interspecific recombination, 2007, Euphytica 154 (1-2): 127-137.



Most *O. glaberrima* accessions, however, have a very limited yield potential due to a limited number of secondary branches on the panicle. *O. sativa* has many more secondary branches than *O. glaberrima*. *O. glaberrima* accessions are susceptible to lodging and grain shattering, have long seed dormancy, and are generally photoperiod sensitive. Contrasting reports can be found on the drought resistance of *O. glaberrima*. Its main advantage in this respect seems to be its plasticity and capacity to regenerate very fast, because of its vigor and organ thinness (Audebert, personal communication).

Some of these characteristics have been known for a long time. For the sake of simplicity, these trait features are often considered as characteristics of one or the other species, but not all accessions of a species have them, or express them at a high level. Large-scale phenotypic evaluations, multi-local for traits with low heritability, are therefore needed to see the pervasiveness of a feature in the genetic resources. In addition, in order to define the best sampling strategy for future work, the organization of the phenotypic variability of a trait in a species has to be looked at through the prism of its genetic structure.

Some overall morpho-agronomic evaluations of the material have been conducted by WARDA<sup>31</sup>, but the Panel feels that a sound and systematic characterization of the above-mentioned specific qualities of more than a few *O. glaberrima* accessions is lacking. Little seems to have been published on these aspects. Hybridization relied on very few accessions well known by breeders, but the overall species variability does not seem yet to have been phenotypically explored. For example, little is known about the weed competitiveness mechanisms attributed to *O. glaberrima*, and their prevalence in the species. A recently commissioned GCP project is a step toward remedying this situation with plans to evaluate drought recovery ability, resistance to RYMV and to bacterial leaf blight of an *O. glaberrima* collection on which a molecular characterization is being conducted (see paragraph below).

***Because the phenotypic variability of O. glaberrima has not been studied as extensively as that of O. sativa, the Panel recommends exploring more systematically the phenotypic variability of O. glaberrima for desirable traits, using sound, up to date screening methods, and focusing on processes and mechanisms of these traits.***

### **Diversity at the molecular level**

The first evaluations of the diversity of *O. glaberrima* with isozyme markers conducted in the 80s concluded that the genetic variability of *O. glaberrima* was limited in comparison to that of *O. sativa*.<sup>32</sup> Two recent interesting studies involved present WARDA's scientists as partners. The first study analyzed on a large scale (300 accessions) the diversity of *O. glaberrima* with microsatellites highly polymorphic in this species. It determined that *O. glaberrima* was

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<sup>31</sup> Jones MP, Dingkuhn M, Aluko GK, Semon M., Interspecific *O. sativa* x *O. glaberrima* progenies in upland rice improvement, 1997, Euphytica 93:237-246 and Semon M, Nielsen R, Jone MP, McCouch S., The population structure of African cultivated rice *Oryza glaberrima*. Evidence of elevated levels of linkage disequilibrium caused by admixture with *O. sativa* and ecological adaptation, 2005, Genetics, 169:1639-1647.

<sup>32</sup> Pham J., Evaluation des ressources génétiques des riz cultivés en Afrique par hybridation intra- et interspécifique, 1992, PhD thesis, Université de Paris XI, Orsay, Paris and Second G., Relations évolutives chez le genre *Oryza* et processus de domestication, 1984, PhD thesis, Université de Paris XI, Orsay.

structured in 5 groups, 2 being strongly admixed with *indica* or *japonica* and the remaining 3 corresponding to a range of ecological adaptations to hydrological environments.<sup>33</sup> The Panel commends the relevance and high quality of this work exploring *O. glaberrima* structure with the best analysis methods, and published in an excellent journal.

Similar work has been done in the framework of GCP sub-program 1, in which 300 accessions of *O. glaberrima* and *O. barthii* were included in the 3000 sample set that was genotyped with 48 microsatellite markers. Because of the difficulties encountered to access genetic resources during this time, the sampling methodology of the *glaberrima* accessions may not have received as much attention as could have been needed. Nevertheless, it should permit to confirm the results from Semon et al. (2005)<sup>34</sup>, and compare more thoroughly the diversity of *O. sativa* versus *O. glaberrima* and that of *O. glaberrima* versus that of *O. barthii*. These results are presently being exploited. The Panel feels that excellent work is globally being done on these diversity aspects.

*To capitalize on the excellent work done on the understanding of the genetic structure of O. glaberrima, the Panel recommends that the Genetic Resources Unit, breeders and molecular biologists of WARDA collectively focus on defining core collections of O. glaberrima, i.e. collection of accessions representative of the diversity of the whole species.* The core collections should include the natural admixed accessions of particular interest because of WARDA's focus on interspecific hybrids. Different imbricated core collections should be constituted, using the best statistical methods, in order to provide breeders, physiologists, weed specialists and pathologists with sets of accessions of different sizes they can use with maximum efficiency and relevance when they want to evaluate *O. glaberrima* accessions for specific traits as suggested above.

#### **2.1.2.2. Other African cultivated genetic resources**

As mentioned above, the African cultivated genetic resources are not only constituted by *O. glaberrima* accessions but also by thousands of *O. sativa* accessions. Despite the relatively recent introduction in West Africa of *O. sativa*, these accessions have evolved long enough in African harsh conditions to have been used all over the world because of their high level of blast and drought resistance. The Panel recognizes the fact that the *O. sativa* accessions have been the object of much more extensive past evaluation of both phenotypic and genetic variability but the successes obtained with *O. glaberrima* should not lead WARDA's scientists to neglect these extremely valuable African *O. sativa* genetic resources.

#### **2.1.3. Present status of the rice improvement programs**

##### **2.1.3.1. Breeding objectives**

WARDA's rice genetic improvement program is organized into the 3 large ecosystems: upland, rainfed lowland and irrigated. The constraints for each ecosystem were presented to us as a long and probably exhaustive list of biotic and abiotic stresses (breeders' oral presentations) but these constraints did not seem to have been hierarchized according to their impact on yield. To our

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<sup>33</sup> Semon M, Nielsen R, Jone MP, McCouch S., The population structure of African cultivated rice *Oryza glaberrima*. Evidence of elevated levels of linkage disequilibrium caused by admixture with *O. sativa* and ecological adaptation, 2005, Genetics, 169:1639-1647.

<sup>34</sup> Idem.

knowledge, no refined stratification leading to a well-defined target population of environments (TPE) has been established. It is unlikely that a single variety can perform well across all rainfed lowland, or all upland conditions of Africa, although the problem is probably less acute for the irrigated ecosystem. Moreover, no socio-economic constraints were associated with the ecological constraints. One was let to assume that the range of socio-economic constraints would follow the risks associated with the ecosystem. A more refined view of production systems in each ecology would certainly be helpful to design sounder objectives for breeding programs, or to assess their appropriateness.

Breeders stated that the diversity within each ecosystem was too large to be easily sub-stratified, and that the importance of constraints varied across countries, and along the ecosystem continuum. Indeed, material developed for the lowlands is being tested in the uplands, and reciprocally, and similarly between lowland and irrigated areas. *Although there are possible spillovers from one ecosystem to another, the Panel is of the opinion that much more attention should be given to the concept of target population of environments (TPE) in each ecosystem, the establishment of TPE boundaries, and the weighing of the importance of the various constraints in each TPE, in order to establish clear priorities and ideotypes for each ecosystem, and relevant selection indices for the breeders* (for methodology and tools, see section 2.2.6 on Priority setting in NRM). A training organized by WARDA on these issues may be useful. From the Panel's understanding, in terms of breeding objectives, the upland rice breeding program is focusing on drought resistance, weed competitiveness, resistance to blast and stems borers, tolerance to soil acidity, and N and P deficiency.

The lowland rice-breeding program is focusing on tolerance to iron toxicity and development of low management plant type with good weed competitiveness. African Rice Gall Midge (AfGM) and RYMV resistances are also important priorities. Climatic change conditions induce the need for shorter duration varieties although these are expected to be more sensitive to transplanting delay. Meanwhile photoperiod sensitive varieties are also needed for the deep lowlands. The parallel development of direct seeding gives increasing importance to vigor and weed competitiveness during the first month of crop growth.

The irrigated rice-breeding program is focusing on tolerance to salinity/alkalinity, extreme temperatures and bacterial leaf blight resistance. Two different programs are conducted, one for the rainy season crop, and one for the dry season crop which is shorter and colder. The practice of double cropping is presently very limited because of climatic, technical and economic constraints. Earliness appears an important breeding objective for the dry season crop to permit double cropping (although not on the same plot in the Sahelian environment).

#### **2.1.3.2. Breeding methods**

The three main breeders for the three main rice ecosystems have all joined WARDA recently, and therefore, the organization of the breeding scheme is not completely settled.

The breeding strategy for the upland and lowland ecosystems, aiming at developing pure lines, is a classical one, except for the exceptionally large investment into interspecific hybridization. The two breeders both evaluate their activity ratio at 60% for interspecific hybrids and 40% for *O. sativa* background. While this ratio is reflected in the proportion of interspecific segregating populations that were developed, most of the recently released accessions seem to be NERICAs. The reasons for such imbalance are unclear. From very early generations (F<sub>2</sub> for the rainfed

lowland ecology), the material is dispatched to different countries (Benin, Nigeria, Togo, Burkina Faso), and the selection done in collaboration with NARS. Because of the importance of NERICAs in WARDA's research, the results obtained with them are analyzed more in depth in the next section (section 2.1.3.3).

The irrigated breeding program, located in the Sahel, is so far mostly using *O. sativa* genetic background. It performs well, with 3 Sahel varieties (108, 201, 202) occupying 70% of the surface, and new *sativa* varieties being released in the Senegal River valley. These varieties are pure lines. In an environment where some farmers reach yields of 10 t/ha, the use of F<sub>1</sub> hybrid varieties can start to be envisioned by these farmers. WARDA could liaise with IRRI and with Chinese institutions, experienced in F<sub>1</sub> hybrid rice breeding programs, and start testing the adaptation of their material to local conditions. The Panel is of the opinion that the F<sub>1</sub> hybrid rice varieties do not deserve yet a large investment by WARDA, since the average yield is closer to 50% of the yield potential in the Senegal valley, since rice is direct-seeded, and since F<sub>1</sub> seed production is technically very complicated. However, preliminary steps are warranted.

Aerobic rice, which was proposed by IRRI as an alternative for irrigated areas with poor water control<sup>35</sup>, was tested in Senegal and is mentioned as promising. Broad scale conclusions in terms of yield loss versus water savings should be obtained soon. Nevertheless, a thorough evaluation of the pros and cons has to be conducted before investing in a breeding program for this system in Senegal, since it seems that water savings that could be needed for cost reduction purposes could first come from better management and delivery at the plot level.

Genetic approaches to reduce losses due to pests and diseases are given high importance in all three ecosystems. This is also true for abiotic stresses such as salinity (irrigated ecology) or iron toxicity (rainfed lowland ecology), for which screening methodologies are well established. Systematic early screenings of segregating lines (from F<sub>3</sub> to F<sub>5</sub>) have been organized in regional nurseries set in countries known to be "hot spots" for the various biotic and abiotic constraints (e.g. St. Louis for salinity, Mali for RYMV, or Mali and Guinea for blast). From what the Panel saw in N'diaye and from discussions with WARDA's pathologist, the work is well conducted, with proper screening methods and experimental designs. This regional screening, that supposes a very good underlying organization, seems to work quite efficiently, and can constitute a good vehicle to share germplasm. One can only regret that it is not implemented every year because of funding issues in some years.

An important trait that is not included in the "hot spot" system is weed competitiveness. We were told that "each upland or lowland site can be considered as a hot spot for weeds". Good and fast screening methods usable in a breeding program still need to be established and/or validated in collaboration with physiologists and agronomists.

Grain quality is seen as important in all ecosystems. Grain quality traits are being evaluated at an advanced stage in Cotonou where a classical laboratory exists. The efficiency of near-infrared spectroscopy, increasingly used the two last decades in rice and other cereals as a fast way to measure grain quality traits in very small samples, would justify an investment in this type of equipment. This tool works particularly well for protein content, which seems to be WARDA's

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<sup>35</sup> Peng S, Bouman B, Visperas RM, Castaneda A, Nie L, Park HK, Comparison between aerobic and flooded rice in the tropics: agronomic performance in an eight season experiment, 2006, Field Crop Research 96: 252-259.

main grain quality target, and would permit larger scale screenings. Poor quality often explains the price differential between imported and local rices. Cleanliness seems to be the overwhelming factor behind the image of poor quality of local rice, and, on this issue, genetics has no solution to offer. On other more global grain quality issues, strengthening of the research would be useful. This could also be an area of closer collaboration with strong rice quality laboratories (IRRI, CIRAD).

### 2.1.3.3. Interspecific *O. sativa* x *O. glaberrima* hybrids (NERICAs)

The choice was made in the 90s to invest heavily in interspecific hybridization, originally for the upland ecosystem. The qualities described above make *O. glaberrima* a potentially good complementary type to *O. sativa*. The overall strategy was well described.<sup>36</sup> The Panel commends the decision made by WARDA to exploit the African rice gene pool seldom used before, and is truly impressed by the results obtained from the interspecific hybridization, and the constancy and patience that was needed to obtain the first releasable progenies.

Interspecific hybridization between *O. sativa* and *O. glaberrima* is not any longer a technical problem. We were told that breeders are now able to get interspecific progenies from any combination, and no longer need very advanced backcross generations or the use of anther culture. This generalization of the interspecific hybridization success is a second very important achievement. Nevertheless, two backcrosses and a screening generation on fertility are still needed, which means that interspecific crosses will never be as easy to handle as intraspecific crosses, and fertile progeny production will always take more time.

The difficulties encountered in the first generations of crosses, however, translated in a very narrow genetic basis of the initial progenies: only one *glaberrima* accession (CG14) and three related *sativa* varieties (WAB56-104, WAB56-50, WAB181-18) are the parents of all the upland NERICAs presently released. Another *glaberrima* accession (TOG5681) and a *sativa* accession (IR64) are the parents of almost all the released lowland NERICAs.<sup>37</sup> In addition, at least for the first generation of NERICAs, the crossing barriers required the use of a large number of backcrosses on the *O. sativa* parent, in order to restore fertility. The molecular profiling of the NERICAs showed that 8.2% and 7.9% of upland and lowland NERICA genomes respectively originated from *O. glaberrima*. Thus, the introgressions affect a very small part of the genome, notably considering the fact that all interspecific progenies carry the same *glaberrima* allele, probably involved in hybrid fertility, at a specific segment of chromosome 6 that carries the *S1* gene (also noticed in independent progenies developed at CIAT).

The narrow genetic basis and large similarities between lines carries the intrinsic risk associated, as in any other crop, with a largely monovarietal situation. Such a risk may be the trade-off of NERICA's success. The worst may not occur, as seen by the yield sustainability of IR64 grown in millions of hectares in Asia, but there are examples of the opposite as well. All breeders are aware of the classical example of potato, where the growth of a unique variety susceptible to

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<sup>36</sup> Jones MP, Dingkuhn M, Aluko GK, Semon M., Interspecific *O. sativa* x *O. glaberrima* progenies in upland rice improvement, 1997,

<sup>37</sup> Rodenburg J, Diagne A, Oikeh S, Fukatuchi K, Kormawa PM, Selon M, Akintayo I, Cissé B, Sié M, Narteh L, Nwilene F, Diatta S, Sere Y, Ndjondjop MN, Youm O, Keya SO, Achievements and impact of NERICA on sustainable rice production in sub-Saharan Africa, 2006, International Rice Commission Newsletter, 55:45-58.

potato late blight led to major crop failures in the 1850s in Ireland. The Panel is aware that steps have been taken to remedy this situation, and encourages more effort in this direction.

*Since the interspecific hybridization sterility problem has been solved, the Panel recommends that WARDA greatly broaden the set of *O. glaberrima* and *O. sativa* accessions used as parents in interspecific hybridization, using the results of phenotypic and molecular characterizations to ensure larger diversity of parents, monitoring closely the level of introgression and the genetic diversity of the released progenies. The creation of a first generation of interspecific hybrid progenies (NERICAs) should not be seen as the end, but as the beginning of a great "genetic adventure" aimed at making the best possible use of the African gene pools (*O. glaberrima*, *O. sativa* and other species).*

The Panel commends the way molecular markers have been used at breeders' benefit in the case of the NERICA molecular profiling. The Panel wants to underline the very strong interest for breeders in the availability of such molecular profiles to guide their work, and the importance to optimize the integration of molecular markers in their day-to-day work. Any modern breeding program should have direct access to a molecular marker laboratory. What is presently possible for the upland and lowland breeders with the Cotonou laboratory should also be envisioned for the irrigated breeder in Senegal. Both the establishment of a laboratory in N'diaye, and the possibility of sharing CERAAS unused equipment and facilities at Thies in Senegal should be explored.

NERICA varieties for both the upland and the lowland ecosystems have been produced and released. WARDA wants to produce NERICAs for irrigated ecosystems. In fact, three varieties derived from the rainfed lowland program have already been recommended for the irrigated ecosystem. The Panel wishes that WARDA thoroughly weighs the interest of this approach before launching a larger interspecific program. The yield ceiling in *O. sativa* under irrigated conditions, as favorable as the ones observed in the Sahel, is very high, with an average of 5.5 t/ha during the rainy season. In similar favorable conditions in Egypt, *O. sativa* reaches 8 t/ha on average (FAONET, 2004). *O. glaberrima* is known to have much less secondary branches than *O. sativa*, and does not seem like an obvious parent in this context. Therefore, the Panel does not see a reason for the breeding program to deviate from its focus on *O. sativa*, which has been very successful. Because it will take more time to reach a releasable product with interspecific hybridization than with intra-specific hybridization, there should be very good reasons, based on a clear view of the required *glaberrima* intrinsic qualities, before investing further into interspecific hybridization. Increased diversity *per se*, which was the reason mentioned to us, seems a weak reason for this endeavor, since more diversity can also be obtained through intraspecific hybridization.

To demonstrate the interest of NERICAs for the upland and lowland ecosystems, comparisons were made with classical *O. sativa* material. Several results demonstrated that some NERICAs had a yield advantage over *sativa* accessions under low fertility conditions, but others seemed to show that the results were less clear-cut, notably when the comparison involved a large number of accessions.<sup>38</sup> The Panel is of the opinion that the comparisons were not always as thorough as

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<sup>38</sup> Rodenburg J, Diagne A, Oikeh S, Fukatuchi K, Kormawa PM, Selon M, Akintayo I, Cissé B, Sié M, Narteh L, Nwilele F, Diatta S, Sere Y, Ndjondjop MN, Youm O, Keya SO, Achievements and impact of NERICA on sustainable rice production in sub-Saharan Africa, 2006, International Rice Commission Newsletter, 55:45-58.

they should have been, not always including enough *O. sativa* accessions to get an idea of the compared variability of both backgrounds. A good characterization of the trial biophysical and socio-economic environments that could help understand the NERICA or *O. sativa* response heterogeneity is also often lacking.

**The Panel expects that data, notably yield data, on performances of all types of varieties, be accompanied by proper descriptive elements (e.g. fertility level, cultural practices, cropping system, stress nature) necessary to help understand the variation of responses according to environmental factors.** Moreover, in most reports, yield is the trait being given emphasis, but seldom is attention paid to the specific traits from *O. glaberrima* initially said to be interesting. To focus on these traits could help assess whether these traits were indeed transferred into the NERICAs and could be the source of an improved performance, or whether such improved performance was due to the complementarities of the two parental backgrounds. One has to realize that when a progeny expresses a favorable trait at a high level, the source of the favorable allele can be either of the two parents (for NERICAs, the *O. sativa* as well as the *O. glaberrima*). For a quantitative trait, which is controlled by many genes, a progeny can also be superior to both parents when none of the two parents has all favorable alleles at all genes if, through the hybridization and recombination process, all the favorable alleles are cumulated in the selected progeny.<sup>39</sup> This genetic phenomenon is called transgression. For further breeding work it is important to know what the source(s) of the favorable alleles is/are and what type of situation is encountered.

One study from WARDA showed that the high specific leaf area of the *glaberrimas* was partly retained in the NERICAs during early growth<sup>40</sup>, but no clear link was established between this factor and the better yield performance of the NERICAs. The same remark can be made for the high protein content attributed to some of the NERICAs. The source of most of the favorable alleles is the *sativa* parent, the *O. glaberrima* parent CG14 being very poor in this respect, in contrast with most *O. glaberrima* accessions.<sup>41</sup> Transgressions above the *O. sativa* parent can explain the progeny behavior. While the NERICA ideotype was designed to be competitive with weeds, this quality is not observed in the final products. According to survey results, NERICAs do not appear as weed competitive in farmers' eyes (e.g. Uganda, Guinea), an opinion which is confirmed also by NARS's scientists during the Panel's field visits.

NERICAs have other qualities, however. The main reason for NERICA preference in some areas seems to be earliness. Very early duration itself was not an expected quality for the interspecific hybrids even if the *O. glaberrima* parents were photoperiod insensitive. Among the *sativa* parents, only the upland ones can be seen as early. We have seen that transgressions can be obtained with good allelic complementarities, but this confirms that more attention should be paid to the

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<sup>39</sup> Parent A may carry alleles (+ + + - -) at 6 genes; Parent B may carry the complementary alleles (- - - + -). A progeny derived from this cross could carry alleles (+ + + + +) and, then, be superior to both parents. Another may carry alleles (- - - - -) and, then, be inferior to both parents.

<sup>40</sup> Jones MP, Dingkuhn M, Aluko GK, Semon M., Interspecific *O. sativa* x *O. glaberrima* progenies in upland rice improvement, 1997.

<sup>41</sup> Juliano BO and Villareal CP 1993. Grain Quality Evaluation of World Rices. International Rice Research Institute, Manila; Watanabe, H., Futakuchi, K., Jones, M.P. and Sobambo, B.A. 2004. Grain protein content of African rice (*Oryza glaberrima* Steud) lines and Asian rice (*O. sativa* L.) varieties in West Africa. *Oryza* 41: 35-38).

understanding of the genetic control of all-important traits in both *O. glaberrima* and *O. sativa* backgrounds.

Since the need for early varieties seems relatively widespread, even when the rainy season is not short everywhere, one explanation for the preference of early varieties may be the need for rice during the "hunger period", between the moment when previous year food stocks run out, and the new harvest begins. Not surprisingly, that is a period when rice fetches a relatively high price in the market. In other places, the explanation seems to be women's need for cash at a time when kids resume class. The need for early duration varieties is not new. It has been a farmers' request from the 60s onwards, although a shift towards even earlier duration is noticeable. Earliness should have been a feature of the breeding ideotype for similar situations. The major problem associated with early maturity varieties is bird damage, which can be very serious if early varieties do not cover a large contiguous area. The relationship between yield and duration is not linear and at a given point in earliness, the yield "penalty" becomes very important (see also section 2.2.1 on Yield potential and maturity). Attention has to be paid to this trade-off, notably when extreme earliness (60 to 90 days) is mentioned as one of the reasons to undertake *O. barthii* x *O. sativa* crosses.

The earliness attribute constitutes a concrete example of the need for environment stratification in the breeding programs. NERICA's earliness is highly appreciated in some of the upland sites where NERICAs have been tested. For the deep lowland plots, however, photoperiod sensitive varieties are requested by farmers because they allow sowing at any time, but maturity, and therefore harvest, occurs always at the same period, when floods have receded. The existing NERICAs are photoperiod insensitive and will always mature too early in the season so they cannot fill this niche.

Globally, the Panel would have appreciated a more balanced communication on breeding strategy and products. The oral presentations to the Panel focused almost exclusively on NERICAs. It was difficult to get information on what was occurring with *O. sativa* breeding work, which may convey a wrong impression of the Center's overall breeding efforts. NERICAs represent an element, and indeed an important one, in a panoply of solutions to increase yield productivity and stability in some situations, but they are not the unique "silver bullet" for all environments and conditions.

#### **2.1.3.4. Advanced breeding lines testing through PVS**

In the 90s, participatory varietal approaches started to be used as a way to speed up the diffusion, and improve the adoption of improved material. Among the various approaches of participatory plant breeding described by Witcombe (1997)<sup>42</sup>, WARDA chose participatory varietal selection (PVS) that involves tests in farmers' fields of a large range of fixed lines and selection by farmers. This has shown to be quite an efficient system.

This strategy is a strong positive point of WARDA's breeding approach. The type of PVS system chosen is simple enough to be adopted everywhere. Its principle is to set a varietal garden of around 50 lines in a farmer's field that is visited by farmers 2 to 3 times per season. The next

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<sup>42</sup> Witcombe JR, Decentralization versus farmer participation in plant breeding: some methodological issues. In: New frontiers in participatory research and gender analysis, CIAT, 1997, Cali, Colombia, p.135-154.



season, farmers are given seeds of the three lines they selected, for on-farm testing. PVS has been used in all ecosystems, and seems to be working well, although the Panel considers that one year of testing is not sufficient to get a clear idea of the line performances in a site. The fact that only the top four varieties selected by farmers are chosen for seed production and distribution seems also to go against PVS principles of giving farmers access to a large basket of varieties.

A major issue in PVS is scaling up from limited well-organized trials. Participatory selection effectiveness can come from two factors: First, the decentralization of the trials into farmers' fields; and/or second, the participation of farmers who use criteria different from those used by breeders to make their varietal choice. Disaggregating the effects of the two factors is useful to determine how to scale up.

Concerning the decentralization effect, the Panel is of the opinion that more added value could be obtained from the work done with little additional effort. The initial varietal garden could easily be designed in a way that the data that were collected (duration, height, and yield) could be scientifically exploited (e.g. by the use of a randomized trial with a simple augmented design in which only a few checks are replicated). Genotype-Environment (GxE) interaction analysis of the results could be invaluable. The mother-baby trial system used in maize<sup>43</sup> and in rice<sup>44</sup> could also be introduced as an improvement of the present PVS system, permitting better exploitation of PVS trial results.

*Moreover, no attempt seems to have been made by WARDA to systematically cross farmers' varietal choices with farmers' socio-economic characteristics. The use of such data that are being collected anyhow would add significant value to the global PVS approach, and may help to understand what may appear as contradictory results in farmers' varietal choices.* It may not be possible to conduct detailed studies everywhere, but more integration should be attempted, at least in places where data are collected both by breeders and by socio-economists.

Concerning the farmers' participation effect, PVS is also a way for breeders to get feedback on their products, and it should, in return, help breeders to better design the new generation of varieties. A remark was made to the Panel that, in some cases, farmers chose NERICAs because they are taller than their *sativa* equivalents. This type of requirement, as well as the need for earliness, mentioned above, should not be too difficult to factor into WARDA's breeding programs. However, it is unclear to the Panel whether such systematic feedback process exists and how it is exploited by WARDA.

Grain quality is known to be a factor not always well taken into account in classical breeding programs, especially when the target population produces for home consumption rather than for sale in the market. It is also well known that "quality" can have completely different meanings in different areas or social groups. The practice of parboiling or not parboiling, both common in Africa, complicates the clear definition of requirements. Sensorial evaluations are conducted, which is commendable. But again, we could not see how the resulting information on requirements by various populations was fed back into the objectives of WARDA's breeding programs.

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<sup>43</sup> Snapp, 1999; Bänzinger and Diallo, 1991

<sup>44</sup> Atlin G, Paris T, Courtois B., Sources of variation in rainfed rice PVS trials: implications for the design of "Mother-Baby" trial networks. In: Proc. Workshop on Quantitative analysis of data from participatory methods in plant breeding, 23-25 August 2001, Justus Liebig University, Germany.

An issue in plant breeding is the compromises that have to be made between traits. Breeders know that genetic correlations sometimes hamper the development of the best product. Farmers cannot always find their dreamed variety within the proposed set. Assessing the trade-off between farmers' preferences and what breeders are able to offer may bring valuable information. Simple methodologies to evaluate such trade-offs have been developed in Asia<sup>45</sup> that could be easily used in Africa.

A limitation to broad PVS use is the huge transaction costs for the farmers, for the breeders, and for the extension workers involved. Risks of discouragement are on both sides if the varietal basket offered to farmers does not include material of sufficient interest to them. Therefore, the Panel would like to give a warning about the testing of material with too narrow a genetic basis, involving too many sister lines (e.g. NERICAs only), because such strategy may have negative long-term effects on farmers' motivation.

A last but not less important concern with PVS is that it bypasses the official national release system. This has created important problems for PVS projects conducted in India, notably because governmental support (seed production, extension, etc.) was devoted to accessions that followed the rules and standards of the official release system (on-station trials with standard inputs). While official release systems do not exist everywhere in Africa or may be more flexible than in South Asia, the possibility of conflict has to be envisioned. Ways to incorporate results coming from PVS trials and to factor them into official varietal release systems and policies being developed need to be found. The recent example mentioned to us of problems caused by the uncontrolled introduction by Chinese bilateral collaboration of an accession from Taiwan, highly susceptible to bacterial blight, shows that the total absence of rules can be very detrimental to farmers.

#### **2.1.3.5. INGER-Africa**

One of the vehicles for varietal diffusion is the International Network for Germplasm Evaluation in Rice (INGER). Although organized on a continental basis, it allows the exchange of promising material between continents as well, permitting a regular infusion of elite lines into NARS breeding programs. As highlighted in the 4th EPMR, for countries where breeding programs are weak or inexistent, INGER is an essential and appreciated mechanism to access improved varieties. It is through INGER-Africa, housed in GRU, that germplasm developed by CGIAR Centers and NARS from Asia, Latin America and Africa is made accessible to the NARS of Africa.

Despite its invaluable role, INGER has had, all over the world, strong difficulties in sustaining its funding since the mid90s. INGER-Africa was no different, when funding from DFID stopped in 2002. This funding instability has translated into a decrease of INGER's activities in Africa. However, the situation seems to be improving. WARDA, which rightly values this network, has recently recruited a coordinator for INGER-Africa. Part of the funding from Canada's CIDA, secured within the framework of an IRRI-WARDA collaboration, will contribute to finance INGER-Africa.

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<sup>45</sup> Paris TR, Singh A, Luis J, Singh HN, Singh ON, Singh S, Singh RK, Sarkarung S., Listening to farmers' perception through participatory rice varietal selection: a case study in villages in eastern Uttar Pradesh, India. In Proc. Intern. Symp. on Participatory plant breeding and participatory plant genetic resources enhancement, Pokhara, Nepal, 1-5May 2000, p179-191.

The INGER distribution system has changed in parallel to its financial problems. While in the past the distribution was through structured sets of accessions systematically sent to partners, nowadays it is upon request for specific material. INGER-Africa dispatches requested accessions to African countries and other parts of the world (germplasm consignments, improved varieties, *O. glaberrima* accessions), but at a lower scale than before. The new system may be less costly and does not require logistics as structured as the "old" one, but it results in a considerable loss of information on tested accessions. INGER-Asia and the Maize Network coordinated by CIMMYT have demonstrated the value of these data to get a clear pattern of GxE interactions and a better picture of the mosaic of target environments. Moreover, the systematic diffusion of sets of elite lines allowed breeders to identify interesting material unknown to them (e.g. B6144, an excellent variety from Indonesia that spread all over the world, including Africa, due to INGER's "old" system).

*The Panel recommends that WARDA seek to secure, on a sustainable basis, the funding of INGER-Africa, which is a network essential for the diffusion of genetic progress. The Panel further recommends that INGER-Africa clearly focus on understanding Genotype x Environment interaction patterns across testing sites and capitalize on the benefits that derive from it.*

#### **2.1.4. Biotechnologies**

##### **2.1.4.1. Molecular markers**

Molecular marker laboratories have had to be established in the three places where WARDA's staff were successively located (Bouaké, Bamako and Cotonou). The time and energy lost in the successive relocations had an opportunity cost in terms of scientific production. The Cotonou laboratory is presently operational. The laboratory is globally well equipped, but in the view of the large-scale genotyping activities planned, *the acquisition of a sequencer for genotyping would be useful*. The logistics issues related to the maintenance of a high technology laboratory in a country such as Benin are well under control through good organization and planning. WARDA's staff based in Ibadan also has access to the IITA molecular laboratory through a modest bench fee. The molecular marker laboratories are used for 3 main activities: diversity analyses (discussed above), genetic mapping and marker-aided selection.

#### **Genetic mapping**

Most of the work done so far is about the genetic mapping of QTLs for resistance to RYMV and cloning of a recessive gene of resistance.<sup>46</sup> Parallel work has been conducted on the serological and molecular diversity of the virus itself and its evolution.<sup>47</sup> Excellent papers have been

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<sup>46</sup> Albar L, Ndjiondjop M-N, Esshak Z, Berger A, Pinel A, Jones MP, Fargette D, Ghesquière A., Fine genetic mapping of a gene required for Rice yellow mottle virus cell-to-cell movement, 2003, Theoretical and Applied Genetics. 107(2): 371-378

Albar L, Bangratz M, Ndjiondjop M-N, Jones MP, Ghesquière A., Mutations in the eIF(iso)4G translation initiation factor confer high resistance of rice to rice yellow mottle virus, 2006, The Plant Journal, 47(3): 417.

<sup>47</sup> Fargette D, Pinel A, Abubakar Z, Traoré O, Brugidou C, Fatogoma S, Hebrard E, Choisy M, Séré Y, Fauquet C, Konaté G., Inferring the evolutionary history of Rice Yellow Mottle Virus from genomic, phylogenetic, and phylogeographic studies, 2004, Journal of Virology 78: 3252-3261

published and the resistance gene has been cloned. This is a remarkable achievement, and the strategy developed in this project could be used as a model for further work. This work, done with IRD, results from a long lasting collaboration whose quality and adaptation to WARDA's needs through students' training was emphasized to us.

WARDA is associated with several recent projects aiming at producing resources to facilitate *O. glaberrima* diversity exploitation. The main WARDA-led project involving marker-aided genetic analyses is focusing on drought. It is funded by the Rockefeller Foundation with the objective of developing improved lines with high and stable yield. It represents an individual project (MTP project 4), and is coordinated by a molecular biologist. The project involves three components: a characterization of drought profiles using GIS and AGRHYMET, classical selection and marker-aided selection (MAS), and integrated management options (manipulation of sowing dates, variety growing period and sowing density). The integration of the three components is an excellent aspect of this project, since genetic approaches are too often considered as the unique solution to solve all problems.

Drought resistance is a complex integrative character resulting from the interaction of many traits, sometimes with antagonistic effects, and the importance to be given to the respective traits has to be weighed for each drought profile. The "characterization" component will notably help molecular geneticists and breeders to choose, on a more solid basis, the right secondary traits to focus on. The Panel believes that in project 4, it is essential to ensure a close relationship with physiologists in order to understand the fundamental underlying processes. This is expected to be achieved through interactions with a JIRCAS WARDA-seconded physiologist and continued collaboration with previously WARDA-seconded CIRAD physiologists.

The Panel was initially surprised by the strategy apparently developed for genetic analyses in project 4. The genetic control of drought resistance traits in *O. glaberrima* is unknown, while a very large corpus of information is already available in *O. sativa*. Nevertheless, WARDA started developing four new intra-*sativa* crosses involving parents already used in older mapping populations that carry little chance to bring new information. Meanwhile, teams in CIAT have developed two chromosomal segment substitution line populations (CSSLs) involving an *O. glaberrima* parent (Caiapo (japonica) × IRGC103544; IR64 (*indica*) × TOG5681). These already genotyped CSSLs nowadays constitute, without doubt, the best resource to detect QTLs in an interspecific background and validate them. WARDA, that has already excellent collaborations with these CIAT teams, should put more emphasis on phenotyping this material to detect QTLs for a broad range of traits of interest in African conditions, notably because TOG5681 is the *O. glaberrima* parent of the lowland NERICAs. Good recovery after drought seems to be the main specific drought resistance character of *O. glaberrima* and this trait can be evaluated in the CSSL mapping populations. The Panel was told that the new intra-*sativa* mapping populations are also seen as starting points for marker-aided selection projects, which makes their development more understandable.

The choice seems to have been made to focus mostly on secondary traits. The debate is still ongoing to know whether more progress is to be expected from a selection based on yield under

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Traore O, Sorho F, Pinel A, Abubakar Z, Banwo O, Maley J, Hebrard E, Winter S, Séré Y, Konate G, Fargette D., Processes of diversification and dispersion of Rice Yellow Mottle Virus inferred from large-scale and high-resolution phylogeographical studies, 2005, Molecular Ecology 14: 2097–2110.

stress itself<sup>48</sup>, or from secondary traits with strong correlations with yield under stress and better heritability. Both are commendable but in both cases, the best solution is to go to the root of the mechanisms. Eco-physiologists are presently trying to link their crop models to genetic models.<sup>49</sup> It seems to the Panel that WARDA, by establishing this multidisciplinary team, has the capacity to invest in this promising field, and *the Panel strongly encourages the Center to do so in collaboration with advanced institutions.*

Both the molecular biologist in Cotonou and the one based in Ibadan are focusing on drought. One is looking at the drought response at the vegetative stage and the other at reproductive stage in different intra-*sativa* crosses. The Panel feels that the genetics of drought, already the object of strong efforts worldwide, is certainly an important issue that deserves a critical mass to reach fast result. However, more integration between the two teams and other teams dealing with the issue would be useful.

Meanwhile, the understanding of the genetic control of other traits such as iron toxicity in the lowland ecosystem, salinity in the irrigated, or weed competitiveness in the upland and lowland ecologies, which were all mentioned as important, is not presently the object of any effort. The reason given to the Panel for not investing in the genetics of weed competitiveness was the lack of a weed specialist to help define a good phenotyping methodology, which is indeed necessary. For iron toxicity, the first project submitted to a donor was not funded. The Panel hopes that, with the presence of the new IRRI-seconded breeder in Ibadan, who has experience with salinity and other abiotic stresses, the work on biotic and abiotic constraints can be distributed between the collaborating scientists in order to cover most if not all of these constraints.

Since most NERICAs carry only very limited segments of *O. glaberrima*, NERICAs were also used as near-isogenic lines, and compared to their *sativa* parent to check whether the introgression areas carried genes of interest. This work will be published soon.

QTL detection in mapping populations permitted huge progress in understanding the genetic control of quantitative traits. Its weaknesses, however, lie in the lack of precision in the QTL position, and in the limited number of alleles compared. Association mapping in natural populations, derived from human genetics, is now spreading in plant genetics because it does not show the same shortcomings. The important work done on the genetic structure of *O. glaberrima*, combined to the establishment of *O. glaberrima* core collection suggested in this report, open the way to use this approach directly in this species, and to identify alleles different from the *sativa* ones. WARDA has envisioned a whole-genome mapping approach that would represent an excellent valorization of its previous work and of the in depth characterization that the Panel suggests to conduct on *O. glaberrima* for all its valuable traits. Such enterprise has taken the form of a very large project for drought and disease (BLB and RYMV) related issues, which has been submitted for funding to the CGIAR's Generation Challenge Program, and could be submitted to other donors for other traits.

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<sup>48</sup> Atlin G., Improving drought tolerance by selecting for yield. In: Manual: Breeding rice for drought tolerance, 2003,. eds Fisher K, Lafitte R, Fukai S, Atlin G, Hardy B, IRRI, p. 14-22.

<sup>49</sup> Hammer G, Chapmann S, van Oosterom E, Podlich D, Trait physiology and crop modeling to link phenotypic complexity to underlying genetic systems. Proc 4th Int Crop Science Congress, 26 Sept-1 Oct 2004, Brisbane, Australia.

The Panel agrees that WARDA should push its logic of exploiting African genetic resources up to its limit, and pursue at a larger scale the exploitation of the genetic diversity of *O. glaberrima* that no one else is better placed to do, and which the GRU head, molecular biologists and breeders have already started to explore (SC issue 5).

*The Panel strongly supports the coordinated whole genome association mapping approach undertaken by WARDA for drought resistance traits of interest in O. glaberrima. For higher efficiency, the Panel suggests to build on the experiences accumulated on various species in the Generation Challenge Program, to which WARDA is already contributing. The Panel encourages WARDA to extend the analysis to all traits of interest in O. glaberrima, with the same collection.*

### **Marker-aided selection (MAS)**

#### WARDA research activities

The cloning of the RYMV gene opened large avenues for MAS that are logically explored now.<sup>50</sup> The present work conducted at WARDA headquarters logically concerns the introgression of the resistance allele from Gigante (an *O. sativa* accession from Mozambique) located on chromosome 4, into elite lines such as IR64 and Bouaké 189. The work is presently in BC<sub>3</sub>F<sub>2</sub>.

One concern is the focus of this research on a single gene that has already broken down in some countries. It may be still useful in other countries such as Mali, but its durability is an issue to tackle. Some genetic mapping work has shown that QTLs coming from other accessions such as Azucena can also contribute to partial resistance to RYMV.<sup>51</sup> These QTLs cannot be neglected. The advantage of marker-aided selection is that it could permit the manipulation of several genes at the same time, and the association of a major gene with QTLs seems commendable. It is also important to keep in mind that most environments will require varieties with multiple resistances and that the need to manipulate several traits and several genes per trait will very soon require going further than just back-cross introgression.

Marker-aided selection is also being used to speed up fertility restoration in interspecific hybrids (project Ibridge funded by GCP). In addition, while attempts are being made to develop aromatic rice for the irrigated environment through classical approaches, marker-aided selection approaches should also be explored, since the major aroma gene controlling acetyl-pyroline production is now cloned.<sup>52</sup>

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<sup>50</sup> USAID funds the MAS for RYMV at WARDA since 2004.

<sup>51</sup> Albar L, Lorieux M, Ahmadi N, Rimbault I, Pinel A, Sy A, Fargette D, Ghesquière A., Genetic basis and mapping of the resistance to Rice Yellow Mottle Virus. I. QTL identification and relationship between resistance and plant morphology, 1998, Theor Appl Genet 97:1145–1154

Pressoir G, Albar L, Ahmadi N, Rimbault I, Lorieux M, Fargette D, Ghesquière A., Genetic basis and mapping of the resistance to Rice Yellow Mottle Virus. II. Evidence of a complementary epistasis between two QTLs, 1998, Theor Appl Genet 97: 1155–1161

Ahmadi N, Albar L, Pressoir G, Pinel A, Fargette D, Ghesquière A., Genetic basis and mapping of the resistance to Rice Yellow Mottle Virus.III. Analysis of QTL efficiency in introgressed progenies confirmed the hypothesis of complementary epistasis between two resistance QTLs, 2001, Theor Appl Genet 103:1084–1092.

<sup>52</sup> Bradbury LMT, Fitzgerald TL, Henry RJ, Jin Q, Wtaers DLE, The gene for fragrance in rice, 2006, Plant Biotechnology Journal 3:363-370.

The Panel feels that the molecular marker technology is now mature enough to help improve breeding efficiency. The Panel strongly encourages its use in all cases where genes of interest have been cloned (aroma, salinity with *Salto1*, submergence tolerance with *Sub1*) in addition to the already planned work on RYMV resistance.

#### WARDA's alertness to developments in molecular breeding

The Cotonou laboratory acts as a training and operative center for NARS scientists in molecular marker technology. The training aspects are further described in section 2.5. In addition, WARDA has helped NARS to set their own molecular laboratory in four countries (Mali, Burkina Faso, Guinea and Gambia). The Panel feels that the capacity building effort in this domain is developing very well, that the locations were well chosen, and that the proposed plans are sound. As said before, *the Panel strongly supports the presence of molecular marker laboratories directly in the breeding sites, since simple and robust techniques are now available. In addition to the 4 existing laboratories, the Panel encourages WARDA to set one in N'diaye in Senegal, where the Center is conducting its irrigated breeding program and where the present breeder is quite competent to make the best use of it.*

WARDA's strategy for the future is to let NARS take care of the development of local products through marker-aided selection and focus on more upstream research on genetic analyses and identification of alleles of interest to African countries (SC issue 6). The Panel commends this strategy but underlines that MAS will soon evolve from very simple backcross introgression schemes to more complex genotype building and marker-aided recurrent selection schemes. NARS will rely on WARDA for MAS methodology and, therefore, theoretical developments in this field have to be carefully followed by WARDA's scientists. WARDA also needs to be part of any overall CGIAR initiative attempting to evaluate the cost/efficiency ratio of MAS. Low-cost, fast techniques for DNA extraction and for field genotyping represent an area of research where the technology is still far from being optimized, and on which CGIAR Centers could make further investments.

#### **2.1.4.2. Other biotechnology research activities**

##### **Transgenic approaches**

WARDA does not directly conduct research on transgenics, and does not presently have any comparative advantage to do so. The Center relies on advanced institutions to develop transgenic material of interest to Africa. For example, the John Innes Center (UK) is presently being working on resistance to RYMV, testing a system based on the coat protein that prevents the virus' replication. For the Panel, if needs arose to use genetic transformation at a larger scale, a good option would be to collaborate closely with IRRI, which now has set up a very effective system to introgress any gene of interest into any accession, and is very open to collaboration.<sup>53</sup>

At some point in time, the test of transgenic varieties would have to be done in Africa. This raises the issue of the handling of transgenic plants (need for a transgenic greenhouse) and the status of

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<sup>53</sup> Hervé P., Allele engineering and drought: a simple solution for a complex trait? In: Drought resistant rice for increased rainfed production and poverty alleviation, 2007, eds. Seraj R and Hardy B, IRRI, Los Baños, Philippines (in press).

transgenic crops, first in Benin, and then in the target countries.<sup>54</sup> In Benin, there is a moratorium up to 2007. Since IITA-Ibadan has confinement facilities and an official legislation, work could theoretically be conducted there, although some problems with Nigerian public opinion are to be expected.

WARDA's plant pathologist and molecular biologist therefore, monitor the evolution of the legislation in African countries carefully. The Center is right in getting involved in the development of policies facilitating the correct use of GMOs in Africa, and in ensuring proper information on their biological and social consequences.

WARDA collaborates with the Harvest Plus Challenge Program (HP) but not on genetic engineering activities (SC issue 11). HP seeks to reduce micronutrient malnutrition among the poor by breeding staple food crops that are rich in micronutrients, through a process called bio-fortification. This objective is, of course, of interest for Africa. WARDA indicates to have identified rice varieties with high Fe and Zn content (to be confirmed) through its collaboration with the University of Adelaide (Australia), and envisions marker-assisted breeding to exploit these alleles. This is, in the Panel's eyes, an option globally less problematic than genetic transformation for genes/alleles originating from the *Oryza* genus. The Panel feels that the Center is taking the best possible advantage from its collaboration with HP in the present context of GMOs in West Africa. If the situation were to change significantly, the best strategy to capitalize on the results obtained by HP on other species would be through collaboration with IRRI for genetic transformation of African varieties, as mentioned above.

## Genomics

WARDA has not yet invested in genomics tools, but is considering their use in several areas of structural and functional genomics that could boost progress in molecular genetics and improve marker-aided selection efficiency.

On structural genomics, two *O. sativa* genomes have been fully sequenced and 20 varieties have had the gene part of their genome sequenced (Perlegene project, led by the International Rice Functional Genomic Consortium). Based on this momentum and on the constitution of BAC libraries and BAC-end sequencing of many wild accessions, including African ones, mention has been made to the Panel of the possibility of WARDA sequencing the *O. glaberrima* genome. In the Panel's opinion, although costs have decreased a lot, genome sequencing is still a complex and costly endeavor that can only be taken care of by an international team, led by an advanced institution with large bioinformatics capabilities. Notwithstanding the above, the Panel notes that the sequences of *O. glaberrima* genes would be useful to make marker-aided selection easier to produce and handle. These sequences compared to that of *O. sativa* would allow defining gene markers polymorphic between *O. sativa* and *O. glaberrima* (SNPs or indels), which are among the best markers for MAS. The Panel suggests that, before envisioning any whole genome sequencing project, tests be conducted in collaboration with IRRI to see whether the simpler and cheaper strategy used in the Perlegene project could be used for *O. glaberrima*.

On functional genomics, WARDA is interested in expression studies as a way to identify genes controlling traits of major agronomic importance for Africa, notably drought resistance, by

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<sup>54</sup> Legislation is in place in Burkina Faso, Cameroon and Nigeria, but not voted or not in place in other countries.



comparing accessions of *O. glaberrima* with different levels of resistance. The Center intends to build on existing CGIAR capacities, notably those developed at IRRI as service laboratory. Indeed, the Panel considers that getting staff trained at IRRI, and initially using their facilities, are the best first steps that WARDA should take before considering investing in Cotonou.

## **Bioinformatics**

Bioinformatics needs generally develop with high throughput activities in genomics that do not yet exist in WARDA. No bioinformatics plan has yet been set (SC issue 5). Collaborations with advanced institutions are seen as a way to fulfill the possible future needs. This strategy appears as an adapted, short-term solution to address specialized needs. Nevertheless, it is the Panel's experience that bio-informaticians are becoming more and more necessary if only to exploit the mass of information available in the world's databases. This is particularly true for rice with all the sequencing efforts that have already been made.

WARDA has to take a longer-term view. *The Panel suggests that, capitalizing from the Generation Challenge Program (GCP) momentum, WARDA starts to build a bioinformatics team by recruiting an expert in databases that constitutes the necessary ground for any further work.* Connection with the GCP platform can be a starting point and collaboration should be sought with the joint IRRI-CIMMYT Crop Research Informatics Team (CRIL). The International Rice Information System being developed at IRRI should be analyzed for its suitability to respond to WARDA's needs. Adaptations to WARDA's specificities will certainly have to be introduced but it may be a possible way to gain time and money. Tools around the databases would come next. (This is further discussed in section 2.6.5 on biometrics.)

We suggest that WARDA focus strictly on rice issues, and just establish connections with the main other rice and cereals databases. The extension to other cereal crops in West Africa under WARDA's leadership is not a priority in the present situation. The area of comparative genomics in cereals is well occupied by the Gramene project ([www.gramene.org](http://www.gramene.org)), which has world ambition and recognition, and the duplication of their efforts would just divert WARDA's resources from its core research agenda.

Bioinformatics is defined as informatics applied to genetics and genomic data and does not always include biostatistics. However, in a longer term, the idea of creating a unit comprising biostatisticians, bio-informaticians, and data base management specialists should be considered. The recruitment of an information system specialist could benefit the whole of WARDA's research community, including the GIS and GRU units. Meanwhile, help can also be expected from the IT unit whose head seems quite competent in data base management. The Panel stresses, however, that such developments would not make any sense without a very serious improvement in internet connectivity at WARDA.

### **2.1.5. Concluding comments on rice genetic improvement**

The 2000-2006 period has been marked by the official release of NERICAs for the three major rice ecosystems. The genetic basis of these varieties, however, is very narrow. Interspecific crosses seem now possible, if not easy, for all types of parental combinations. This opens the way for a more comprehensive exploitation of the African cultivated gene pools (*O. sativa* and *O. glaberrima*), which could mark the beginning of a great genetic adventure. Since *O. glaberrima* has not been as thoroughly evaluated as *O. sativa*, it should be the subject of more in depth

phenotypic evaluations for all its recognized valuable traits. The assessment of *O. glaberrima* diversity has started on an excellent basis, and should be pushed to the point of defining core collections that will be useful for all disciplines. The results of phenotypic and molecular evaluations should be combined in a whole genome association mapping study that is, in such situation, probably the best approach to understand the genetic control of the valuable traits, and to identify superior alleles in *O. glaberrima*.

NERICAs have proven to be interesting material in many situations, seemingly because of their short duration. WARDA tends, however, to use them as the only option for a too large variety of situations. It is clear to the Panel that WARDA's breeding program would greatly benefit, in terms of efficiency and impact, from a better analysis of the African agro-ecological and socio-economic environments, and from a definition of homogeneous target zones with their associated ideotypes, and from a better prioritization of the breeding work among these niches. The stratification tools exist at WARDA (see section 2.3), as do the scientists from the needed disciplines. All elements are in place to do the proposed research. The results of this stratification should be factored into the participatory varietal approaches in order for breeders and socio-economists to better understand the reasons behind the variability of variety performances and farmers' choice. Meanwhile, the lack of weed competitiveness in varieties specifically designed to have this quality should be analyzed and lessons drawn for future breeding work.

Very good work has been done during the review period on the understanding of the genetic control of some traits, going up to cloning a RYMV resistance gene, in collaboration with an advanced research institution. Work is only starting for the major abiotic stresses. A clearer division of work between scientists is needed, but the young and dynamic team of WARDA shows promises of producing interesting results. MAS programs have still to prove their efficiency, but laboratory and trained scientists are in place to initiate the first programs at NARS level, and several useful genes are available for introgression.

As a general assessment, the Panel believes that, despite the many difficulties that have marked the review period – with two successive relocations which were very damaging for the continuity of the breeding and genetic programs, and large staff turn over – material was produced, whether intra or interspecific, that has already proven very useful, and the future could be even better. In addition, the Panel stresses that much can be gained in terms of long-term genetic progress by adopting a less empirical approach, with a focus on understanding better the GxE interactions (environment being understood as the combination of the agro-ecological and the socio-economic environments) and the mechanisms explaining superior performances.

## **2.2. Agro-physiology**

Most of crop improvement activities at WARDA have been concentrated on the development of NERICAs. New interspecific hybrids between *O. sativa* and *O. glaberrima* (NERICAs) are expected to have higher yields, earlier maturity, resistance to local stresses, and higher grain protein content. However, questions remain about whether these traits are fully realized in the NERICA varieties, and whether the conclusions reached thus far are supported by agro-physiological evidence.

### 2.2.1. Yield potential and maturity

Many on-station yield trials have shown that some interspecific progenies or NERICA varieties out-yield their parents. However, yield performance of the varieties differs across ecologies (e.g. between irrigated and rainfed<sup>55</sup>), and the reasons for this are not clear, since the physiological basis of yield performance has been poorly researched. One of the few reports testing the photosynthetic and stomatal conductance of varieties from different origins (including one interspecific hybrid, WAB450-1-B-P-38-HB) showed that the interspecific hybrid had similar stomatal conductance and photosynthetic rate to those of elite *sativa* varieties<sup>56</sup>. However, how these traits can increase yields under both no fertilizer and conventional fertilizer conditions remains unanswered. Fujii et al. (2004)<sup>57</sup> compared growth and physiological characteristics of six upland NERICA varieties (1-6) with several *sativa* varieties (including *indica*, *japonica* lowland and upland varieties) under upland conditions. NERICA 2 and NERICA 3 showed a larger biomass and stomatal conductance than did lowland varieties, but large variation existed amongst six NERICAs, suggesting that the agro-physiological traits of NERICAs cannot be generalized.

Earliness of NERICA varieties is probably the most evident characteristic. *The Panel suggests that the relationship between growth duration and yield potential be examined.* If the yield potential of NERICAs is reasonably high for their short duration, the physiological basis of the relatively good yield performance would be worthy of research.

### 2.2.2. Drought tolerance

Despite high expectations, experimental evidence for drought tolerance of NERICA varieties is still limited. Presently, CG14's long and thin roots are the trait that may confer drought tolerance of the interspecific progeny, but there has not been concrete evidence that interspecific progenies have inherited this trait. On-station morphological and physiological evaluation of germplasm for drought tolerance, ongoing under project 4, should help provide a fair evaluation of the drought tolerance of NERICAs. However, this project targets the mid-season (reproductive growth stage) drought only. Therefore, a different strategy is needed to address drought that comes at the early and terminal stages of the crop cycle.

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<sup>55</sup> Futakuchi K, Jones MP, Osiname O. 2004. Development of lowland rice from the interspecific cross of *Oryza sativa* and *O. glaberrima*. Fischer T et al (2004). New directions for a diverse planet: Proceedings for the 4th International Crop Science Congress, Brisbane, Australia, 26 September – 1 October 2004. [www.cropscience.org.au](http://www.cropsscience.org.au)

<sup>56</sup> Ohsumi A, Hamasaki A, Nakagawa H, Yoshida H, Shiraiwa T, Horie T. 2007. A Model Explaining Genotypic and Ontogenetic Variation of Leaf Photosynthetic Rate in Rice (*Oryza sativa*) Based on Leaf Nitrogen Content and Stomatal Conductance. *Annals of Botany* 99:265-273. DOI 10.1093/aob/mcl253.

<sup>57</sup> Fujii M, Andoh C, Ishihara S. 2004. Drought resistance of NERICA (New Rice for Africa) compared with *Oryza sativa* L. and millet evaluated by stomatal conductance and soil water content. Fischer T et al (2004). New directions for a diverse planet: Proceedings for the 4th International Crop Science Congress, Brisbane, Australia, 26 September – 1 October 2004. [www.cropscience.org.au](http://www.cropscience.org.au).

Earliness can reduce the water use of the canopy, and in turn can avoid drought, but still very limited information is available on the water use of NERICAs. Fujii et al. (2004)<sup>58</sup> demonstrated that NERICAs 1-6 use less water, particularly from the deeper soil layer, compared to their parents and *sativa* upland varieties. Whether this is due to limited growth duration or root density is not clear. However, interestingly, NERICAs 3 and 5 produce relatively high biomass with limited use of water, which may also be worthy of further research. Contrary to studies on roots, some scientists hypothesize that the interesting focus for research in drought should be *O. glaberrima*'s ability to recover after stress. Thus, *the Panel suggests that the drought tolerance ability of the O. glaberrima parent and NERICAs be investigated, focusing also on the plant's ability to recover from drought.*

### 2.2.3. Heat-induced spikelet sterility

Very limited information is available for the heat tolerance of NERICAs. But in their study comparing heat tolerance of 18 varieties of different ecotypes (including one interspecific hybrid, WAB450-1-B-P-38-HB), Matsui et al. (2005)<sup>59</sup> demonstrated that the NERICA is rather susceptible to heat-induced sterility, largely due to the morphological traits of its anthers. Because this trait significantly influences pollination under dry conditions, evaluation of this trait in other interspecific progenies is important.

### 2.2.4. Submergence tolerance

A few studies have been conducted to identify the submergence tolerance of interspecific varieties. Futakuchi et al. (2001)<sup>60</sup> suggested *glaberrima* varieties have high elongation (avoiding) ability under submergence, compared to *sativa* varieties. More recent results seem to show that the gene responsible for this ability is different from the recently cloned *Sug1*. Whether this trait is inherited to interspecific progenies is not clear. It is also important to note that submergence resistance traits can vary depending on the types of submergence, and that for long-term submergence, stem elongation may not be a desirable trait.

### 2.2.5. Grain nutrient quality and nutrient use efficiency

Protein rich interspecific progenies have been developed from the cross between CG14 and WAB56-104.<sup>61</sup> This trait was consistently confirmed over many years and seasons, and is thus under strong genetic control. There was no significant negative correlation between protein content and grain yield, suggesting that the high protein trait can be achieved at limited expense

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<sup>58</sup> Fujii M, Andoh C, Ishihara S. 2004. Drought resistance of NERICA (New Rice for Africa) compared with *Oryza sativa* L. and millet evaluated by stomatal conductance and soil water content. Fischer T et al (2004). New directions for a diverse planet: Proceedings for the 4th International Crop Science Congress, Brisbane, Australia, 26 September – 1 October 2004. [www.cropscience.org.au](http://www.cropscience.org.au)

<sup>59</sup> Matsui T, Kobayasi K, Kagata H, Horie T. 2005. Correlation between viability of pollination and length of basal dehiscence of the theca in rice under hot-and-humid condition. Plant Production Science, 8:109-114.

<sup>60</sup> Futakuchi K, Jones MP, Ishii R. 2001. Physiological and morphological mechanisms of submergence resistance in African rice (*Oryza glaberrima* Steud.). Japanese Journal of Tropical Agriculture 45(1):8-14.

<sup>61</sup> Watanabe H, Futakuchi K, Jones MP, Sobambo BA. 2006. Grain protein content of interspecific progenies derived from the cross of African rice (*Oryza glaberrima* Steud.) and Asian rice (*Oryza sativa* L.). Plant Production Science 9:287-293.

of grain yield. Interestingly, however, the *glaberrima* parent, CG14 is a protein poor variety compared to the *sativa* parent, so the protein rich trait is perhaps attributable to the *sativa* parent. Having a high nutrient concentration often results in a lower nutrient use efficiency. Whether the protein-rich interspecific progenies can also be nutrient efficient needs testing.

In conclusion, and following successful development of NERICAs, considerable research emphasis has been put on NERICAs, but the mechanisms and processes behind NERICA's productive potential are generally unknown. Without a balanced and robust research strategy to substantiate claims and understand the fundamentals behind them, WARDA's scientific credibility may be at risk. *Follow-up studies to better understand the O. glaberrima parents and NERICAs, in terms of mechanisms associated with NERICA's superior performance (e.g. higher nutrient-use efficiency, water-use efficiency and productivity, resistance to pest and diseases, protein content and weed competitiveness), are needed and the Panel suggests that these studies be done.* It is important that the target trait is well defined and progeny traits are examined agro-physiologically. More detailed physiological analysis is desirable and this should be done in collaboration with other advanced research institutions.

### 2.3. Rice agronomy and natural resource management

According to the programmatic structure of WARDA outlined in the Medium Term Plan 2007-2009, most of the agronomic and natural resources management research at WARDA cuts across all ecologies in Program 1 'Integrated Rice Production Systems'. The objectives of the relevant projects are:

- **Project 1: 'Enhancing productivity and stability of the uplands rice-based systems':** Enhance the productivity and system stability through usage by farmers of high yielding, good quality, multi-stress-resistant germplasm based on accessions that are characterized and safely preserved in WARDA's genebanks.
- **Project 2: 'Sustainable intensification of the lowland rice-based systems for enhanced livelihoods':** Provide improved technologies that can help farms to exploit the lowlands in a sustainable and profitable manner.
- **Project 3: 'Enhancing the performance of irrigated rice-based systems in Africa':** Promote the utilization of options for integrated crop and natural resources management by farmers in a range of irrigated rice-based systems in Africa.

The biophysical aspects of WARDA's agronomy work within these three projects are complemented by studies on socio-economic aspects of technological, institutional and policy changes (Project 6), strategies for better partnerships and for disseminating rice technologies (Project 7), and local agronomic technology development within the framework of the Inland Valley Consortium (IVC). NRM research is designed to find crop management solutions to tackle major constraints to rice production. The constraints to rice production for the three main rice ecologies are shown in Table 2.1, below:

<b>Table 2.1 Ecosystems – biophysical constraints to increased rice productivity and profitability.</b>		
<b>Ecology</b>	<b>Constraints</b>	<b>Projects</b>
Upland	Drought, nitrogen (N) & phosphorus (P) deficiency, blast, soil acidity, erosion, stem borers, weeds, birds *, rodents *	P1: Upland P4: Drought
Lowland	Iron toxicity, N deficiency, lack of water control, RYMV, AfRGM, stem borers, nematodes, weeds, birds*, rodents*	P2: Lowland P4: Drought
Irrigated	N deficiency, iron, toxicity, salinity, alkalinity, RYMV, nematodes, AfRGM	P3: Irrigated

\* WARDA does not have a comparative advantage for work on birds and rodents.

Source: WARDA Strategic Plan 2003-2012

Rice research has firmly established that rice yield at farm level is determined largely by crop management practices. Considerable progress has been made in the development of intraspecific and interspecific improved varieties. Complementary to this work, WARDA has developed integrated crop management practices for the three major targeted rice ecologies. These developments have led to considerable rice productivity gains in a number of West African countries. However, the huge yield gaps between on-station and farmers' fields in the Senegal River Valley<sup>62,63</sup>, for example, demonstrates that factors other than rice varieties can also contribute greatly to rice production.<sup>64</sup> This is mainly because many crop management decisions at local and farm level increase the productivity and profitability of rice systems. These crop management aspects include decisions on: (a) field preparation; (b) cropping calendar; (c) management of weeds, insects, diseases and other enemies; (d) management of nutrients; (e) water management; (f) harvesting; and (g) drying, storage and other post-harvest activities such as milling and straw management, among others.

WARDA's research on crop management issues is done in close collaboration with NARS and other partners, and include: (a) the sustainable use of natural resources as it relates to rice production (e.g., development of crop management options to mitigate or prevent undesirable environmental effects of rice production such as soil salinization, soil fertility mining, resource-use efficiency); (b) timing of weed operations; and (c) options to improve resource use efficiency, such as improving water productivity and nutrient- and water-use efficiency.

<sup>62</sup> van Asten PJA, Wopereis MCS, Haefele S, Isselmou MO and MJ Kropff. 2002. Explaining yield gaps on farmer-identified degraded and non-degraded soils in a Sahelian irrigated rice scheme. *NJAS Wageningen Journal of Life Sciences* 50(3/4): 277-296.

<sup>63</sup> van Asten PJA, Wopereis, MCS, Haefele SM, Isselmou M. and MJ Kropff. 2003. Explaining yield gaps on farmer identified degraded and non-degraded soils in a Sahelian irrigated rice scheme. *Netherlands Journal of Agricultural Science* 50: 277-296.

<sup>64</sup> Häfele, S., M.C.S. Wopereis, C. Donovan and J. Maubuisson. 2001. Improving productivity and profitability of irrigated rice production in Mauritania. *European Journal of Agronomy* 14(3): 181–196.

### 2.3.1. Crop, soil and nutrient management

#### 2.3.1.1. Upland and rainfed lowlands

Weeds and soil fertility are the major constraints for low rice yields in the uplands and rainfed lowlands. Prior research at WARDA has shown that nitrogen (N) and phosphorus (P) are the most deficient soil nutrients for upland rice production in the humid forest agro-ecological zone (AEZ). In the moist savannah AEZ, N is the most limiting factor, while phosphorus is moderately to slightly deficient. In both humid forest and savannah AEZs, potassium is the limiting after three years of continuous rice production without fertilization. In the semi-arid zone, all macronutrients (N, P and K) have been found to be highly deficient. The integrated soil fertility management (ISFM) approach followed by WARDA has included three aspects: (a) improved management of upland fallow, making use of adapted, weed suppressing, multi-purpose cover legumes as short-season fallows, combined with low-cost soil amendments such as rock-phosphate<sup>65</sup>; (b) the use of fertilizers and other crop management options; and (c) the use of stress-tolerant varieties to salinity, iron toxicity, water-stress, and low inherent soil fertility.

The Panel notes that WARDA's soil fertility research activities include fertilizer response trials of varieties, and the search for indigenous sources of available soil nutrients or fertilizers in the uplands. The results have led to the development of optimum inorganic fertilizer requirements for the released NERICAs and other *O. sativa* improved varieties for the various agro-ecosystems from the AEZ to northern Guinea savannahs. Good recommendations for low and high input farmers have been developed. These include a survey of mineral occurrences, which are a more affordable alternative to the expensive and often unavailable fertilizers that can be used by small-scale farmers. In addition, crop management practices to improve soil fertility have been developed. Crop management options that have been developed in accordance with the ISFM approach include fallow legumes, legumes as cover crops, residue management, the use of rock phosphate, and combined use of legumes and rock phosphate. Finally, WARDA's research on the nutrient balance of upland rice cropping systems, P-uptake, nutrient use efficiency and recovery, and N fixation from legumes has improved understanding of the nutrient cycle.

In the rainfed lowlands to intensified-lowland continuum, crop response to soil fertility is often influenced by water availability and water control and management. WARDA has developed soil fertility approaches for intensification of lowland rice-based systems, which include the application of watershed management methods for inland valleys for optimizing nutrient resource use, and the development of improved water control and crop management for better productivity and the subsequent adoption of water control technologies by farmers. Other crop management options developed include dry-season cultivation of legumes, vegetables and root crops, and double cropping of rice. Capturing (N-fixation), retaining and recycling upland soil N through deep-rooting crops (e.g., pigeon pea), and capturing loss-prone N in the hydromorphic fringe or during the pre-rice cropping to reduce the release of gases to the atmosphere have also been studied. Soil organic carbon plays a major role. Some of this work was done within the framework of the Inland Valley Consortium (IVC), discussed further below.

Inland valleys constitute an important agricultural and hydrological asset at local and national levels, and can make a major contribution to food security and poverty alleviation in SSA. They

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<sup>65</sup> The incorporation of legumes increases rice yields through N and phosphate accumulation and the weed suppression effect.

cover approximately 190 million hectares in SSA, which is about 8% of the land area. However, only a small fraction of the inland valleys, probably less than 15%, is currently utilized. WARDA is the convening Center for Inland Valley Consortium (IVC), a system-wide initiative, since the latter's inception in 1993. At different points in time, NARES of 7 countries, IITA, CIRAD, and Wageningen UR have participated in the IVC. The IVC completed its phase II (2000-2005), and has started implementing phase III (2006-2010). In addition, IVC has managed to secure funding outside its traditional donors for its networking activities (WB, GTZ), and positive prospects exist to secure additional funding from traditional IVC donors in the near future (SC issue 12). The IVC has conducted soil and water management research in the countries in which it operates. Biophysical and socio-economic characterization work of inland valley dynamics and crop production systems in 18 key sites has continued, and was extended to 3 benchmark sites.

The IVC has established a GIS unit at WARDA, and has developed the West African Inland Valley Information System (WAIVIS) that has facilitated access of NRM information to WARDA scientists and participating countries. This information is also being used by IWMI and FAO. Ongoing work includes the development of the national inland valley information system of Africa (NIVISA), a country specific database that will allow cross-country analysis. The Panel considers that this development is of great importance for future research planning and targeting at WARDA and NARS (see also section 2.2.5). (The IVC is discussed further in section 4.1.5.)

In 2006, WARDA established a soil laboratory in Cotonou with financial support from ARI, ROCARIZ and JICA, as well as technical support from the IITA analytical services unit. The soil and plant laboratory's main equipment includes an Atomic Absorption Spectrophotometer (AAS), an Auto-analyzer, a water distiller, mechanical shakers, a digestion block, a neutron probe, a Time Domain Refractometer (TDR) and pH and electric conductivity gauges. This unit has the capacity to conduct routine soil and water analyses (laboratory and field measurements), and the Panel considers this a very positive development to support WARDA's NRM research. **However, the Panel suggests filling the soil laboratory assistant position, and that necessary steps are taken to improve the capacity of WARDA and NARS scientists to access and use data stored in WAIVIS and NIVISA. Furthermore, the GIS unit team should conduct GIS/GPS<sup>66</sup> short-courses to researchers, irrespective of their disciplinary background.** Field information should include geographic coordinates in order to gradually build an interdisciplinary database of field information that can spatially be combined, displayed and integrated to existing database information. Because information from various thematic disciplines can be integrated using GIS/GPS tools, their use by all scientists can also contribute to enhance interdisciplinarity and to make an integrated approach to rice production at WARDA a reality.

Another major contribution of IVC for WARDA's research agenda has been the development of screening tools for iron toxicity. As a result, tolerant varieties have been identified, and location-specific NRM management options have been devised and disseminated to farmers through NARS. Developments in this regard also include contributions to a better scientific understanding of the processes and mechanisms for iron toxicity for inland valleys in West Africa.<sup>67</sup> The Panel commends WARDA (and the IVC) for taking a leading role in research on iron toxicity, and for publishing good scientific work in this area.

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<sup>66</sup> Global Positioning System.

<sup>67</sup> Audebert, A., L.T. Narteh, P. Kiepe, D. Millar and B. Beks. 2006 (eds). Iron Toxicity in Rice-based Systems in West Africa, Africa Rice Center (WARDA).Cotonou, Benin. 175 p.



The IVC has also developed the Participatory Learning Action Research (PLAR) methodology with WARDA's social science team, an approach that combines agronomic and socio-economic on-farm research, bringing together researchers, extension agents and farmers. In the rainfed lowlands, the IVC has made a concerted effort in the development of soil and water management options (leveling, bunding, etc) that are now available to NARES and farmers. This work is being consolidated and expanded to include diversification into rice-vegetable cropping systems.

More recently, and despite a reduction of funds from traditional donors (EU, DANIDA and France), and building on the results of Phase I and II, the IVC has facilitated the formulation of country level research projects by NARS in region. As a result, the following three country projects have secured funding: (a) Community-based Fish Culture in Irrigation Systems and Seasonal Floodplains project (under the CGIAR Water and Food Challenge Program); (b) Sustainable productivity improvement for rice inland valleys in West Africa (UN-CFC funded); and (c) Promoting ant-based pest control in tree crops in West Africa (funded by the Foundation on conservation, food and health). Projects in the pipeline include: (a) Valorization of underutilized traditional vegetables grown in West African lowland rice systems (GTZ); and (b) Promotion of viable small-scale irrigation for food security and poverty alleviation in West Africa (IWMI and Belgian Government). At this point, the Panel would like to note that all of these country-specific projects are only coordinated by IVC, and are not core WARDA projects (SC issue 9). In the Panel's opinion, these achievements are commendable.

In general, very good papers have been published and a lot of progress has been made in the development and dissemination of best-bet technologies, and in understanding the processes and mechanisms of soil and nutrient management, both in the uplands and rainfed lowlands. The work is relevant and of good scientific quality. This is a commendable achievement. However, based on the analysis of recently (2003-2006) submitted papers on agronomy and soil fertility improvement research, the Panel is concerned with what appears to be a focus mostly on NERICAs. Even taking this bias into consideration, the balance seems to be in favour of applied research (response trials) versus strategic research (understanding crop and soil processes and mechanisms), e.g. research to confirm whether NERICAs have indeed better nutrient- and water-use efficiency, and on identifying soil processes and mechanisms responsible for the perceived better uptake of water and nutrients, including mechanisms responsible for producing protein-rich NERICAs in N-poor soils. *In this respect, the Panel suggests that a better balance between "strategic" and "applied" research be considered in future crop and soil fertility research.* In addition, and in view of the need to support current activities and to attain sustainable intensification and utilization of (fragile) rainfed lowlands, *the Panel suggests that future work could include research on understanding the effects of rice-based cropping systems on soil quality (e.g. biogeochemistry aspects of organic C dynamics, including soil macro- and micro-fauna biodiversity) across soil types and hydrological conditions (continuum between upland to intensified rainfed lowlands).*

#### 2.3.1.2. Irrigated environment

Average yields in irrigated Sahelian systems are around 4 to 5 t/ha. Studies conducted by WARDA have shown that yield gaps between actual and potential yields often range from 2 to 8 t/ha, indicating considerable scope to increase yields. In general, double cropping of rice practiced in only 20 % of the cropped area under irrigation in the Sahel.<sup>68</sup>

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<sup>68</sup> WARDA, Annual report, 2001.

In recognition of the potential and growing importance of the lowland ecology in Africa, WARDA has developed irrigated lowland NERICAs. Some of these interspecific lines have been found to have a yield advantage of 7 to 25% over the dominant varieties *Sahel 108* and *Sahel 202*. However, *Sahel 108*, *201* and *202* are still the most dominant varieties in the irrigated Senegal River valley.

Rice yield, productivity and profitability under irrigation can be improved because irrigation allows more control of the timing, mode and dosage of crop and natural resources management interventions, especially water, fertilizers and herbicides. Furthermore, in irrigated systems, labor is often a limiting factor, which explains why mechanization is relatively widespread compared to upland and rainfed lowlands. In this respect, labor-saving equipment developed by WARDA, such as small reapers and thresher-cleaners, are having a major impact in alleviating labor and cropping-calendar constraints in irrigated systems, and in some instances, are allowing double cropping, which has resulted in productivity gains.

The effect of water management is linked to soil fertility and weed management.<sup>69</sup> WARDA has developed an innovative and integrated crop management (ICM) decision tool called RIDEV for crop and natural resources management for the irrigated lowlands. RIDEV finds optimal combinations between individual technologies and natural resources conditions (soil, water, climate, organisms) using decision support systems and modeling tools. RIDEV continues to be improved, and is used to advise farmers on best timing of crop management interventions, while the crop growth model ORYZA is used to determine potential rice yields. Both RIDEV and ORYZA are complemented by the model for fertilizer recommendations (FERRIZ) which is an adaptation of the QUEFTS model that is now calibrated for rice in the Sahel. The combination results in an array of management options that are undergoing adaptive evaluation with farmers. Farm modeling results in the Sahel show significant gains in yields and profits from ICM under farm conditions. The research on the irrigated lowlands is well planned and uses a good, balanced, integrated approach to increase profitability and productivity of irrigated rice systems.

WARDA's ICM work is supported by extensive studies on individual technologies such as for the development of fertilizer recommendations and weed management. Weed management options in the irrigated rice in the Sahel have focused on the combination of chemical and non-chemical measures while several years work on soil fertility has led to targeted recommendations for fertilizer management for irrigated rice in the Sahel. Overall, N has been found to be the most important nutrient for the Sahelian irrigated rice, while phosphorus has proven to also be required for highest yields. This characterization work has led to the development and subsequent improvement of fertilizer recommendations in the irrigated rice-based systems through the calibration of FERRIZ. Initial testing in the Niger and Mali stations shows that FERRIZ offers a better framework to improve fertilizer recommendations as the adjusted doses to three soil fertility classes have outperformed current uniform recommendations. Since water management should be streamlined into current rice research, the *Panel suggests complementing current soil fertility and sowing date modeling with irrigation/hydrology modeling for better estimation of potential and actual crop yield scenarios caused by NRM interventions and improving irrigation delivery systems at scheme and farm levels. Furthermore, because vegetables ranked first in recent CORAF priority setting in the*

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<sup>69</sup> Poussin-JC, Wopereis MCS, Debouzie D and Maeght-JL. 2003. Determinants of irrigated rice yield in the Senegal River valley. *European Journal of Agronomy*. 19(2): 341-356.

*Sahel of West Africa and rice-vegetables is a common rotation in West Africa<sup>70</sup>, the Panel suggests that more research be conducted on rice-vegetable systems.*

Research in the irrigated lowlands has also shown how to mitigate soil degradation, a key aspect for maintenance of high productivity and sustainability in this highly productive environment. For example, ongoing work in the Senegal River valley has clearly demonstrated that good management of soil fertility can maintain yields<sup>71</sup>. However, in view of the slight yield decline being observed, the Panel suggests that *soil fertility long-term trials be continued and possibly be replicated elsewhere. Nutrient balance studies and soil quality aspects could couple experiments. In addition, the Panel suggests that WARDA considers research on development of simple methods for monitoring and analysis of the adverse effects caused by irrigation (including spatial analysis GIS/RS and geo-spatial, quantification of methane emissions and soil quality aspects) and the development of appropriate management options to reduce their impact on rice productivity and on the environment. The Panel commends the excellent output on soil and nutrient management (SC issue 8) and suggests that WARDA could benefit greatly from collaboration with CIAT-TSBF on integrated soil fertility management (e.g. biogeochemical aspects of C-dynamics, soil fertility network – Afnet network and exchange of knowledge on their current CP Water and Food).*

### **2.3.2. Water management**

Water has become an increasingly scarce resource worldwide and in Africa. This affects mainly the irrigated lowland ecosystem but also the rainfed lowlands. Rice is a very water-consuming crop, but does not require permanent flooding for better production. Therefore, water management strategies geared toward saving water used by the rice crop are needed to sustain rice crop production (mainly in irrigated lowlands) and for reducing effects of salinization, water logging and methane emissions. In this context and on the *SC issue 3 – Is WARDA's research on irrigated rice appropriate to the policy environment in Africa?* Water management strategies developed by WARDA in the Sahel have been found to be quite efficient in depleting the salt content of the cropped soil over a period of years. Tools have been developed to make monitoring of soil salinization easier. In addition, recommendations for drainage and crop management are now available so that farmers and extension services can use these to minimize the negative impact of rice cultivation on soil quality.

Water research at WARDA includes characterization of rice production in irrigation systems<sup>72</sup> and studies on effects of water management on lowland rice productivity and profitability, cultivar responses to varying levels of soil and flood water salinity, the hydrology of inland valleys, effects of rice cropping on alkalinity, and improved water control and crop management

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<sup>70</sup> Erenstein O, Sumberg J, Oswald A, Levasseur V and H Kore. 2006. What future for integrated rice-vegetable production systems in West African lowlands? *Agricultural Systems* 88: 376–394.

<sup>71</sup> Mando A, Ouattara B, Somado EA, Wopereis MCS, Stroosnijder L and H Breman. 2005. Long-term effects of fallow, tillage and manure application on soil organic matter and N fractions and on sorghum yield under Sudano-Sahelian conditions. *Soil Use and Management* 21(1): 25-31.

<sup>72</sup> Segda Z, Haefele SM, Wopereis MCS, Sedogo MP and Guinko S. 2004. Agro-economic characterization of rice production in a typical irrigation scheme in Burkina Faso. *Agronomy Journal* 96 (5) 1314-1322.

effects on lowland rice productivity.<sup>73,74</sup> Most water management work is concentrated in the irrigated areas. Although the quality of science of the research conducted is very good, water management research is very limited in quantity even for the irrigated areas. For example, an analysis of peer-reviewed papers over the period under review shows that water management output only represents 5% of the total of peer-reviewed papers published. Nevertheless, irrigation water efficiencies are very low. For example, the Panel was told that 30,000 m<sup>3</sup>/annum is used for rice production in Office du Niger, Mali (gravity irrigation system).

Our findings concur with results from the donor review of IVC (2004) and the CCER on IGNRM<sup>75</sup> that have also identified the weakness in water research as it relates to rice production at WARDA, with recommendations for strengthening this area. These include measures to strengthen and widen research on NRM, allocate funds and increase Center's critical mass. New permanent appointments of staff should include a hydrology/irrigation engineer and a land development engineer (CCER on IGNRM). In addition, IVC review recommended training (formal and informal) of NARS scientists in water management and GIS. They also suggested that in order for WARDA to strengthen its current water management capacity, it should collaborate more closely with relevant CGIAR Centers, notably IWMI and IRRI, advanced research institutions such as CIRAD and Wageningen UR and FAO.

In the uplands, rice is grown under rainfed conditions, so the scope for improving yields through better water management is very limited but considerable scope exists for better utilization of rainwater for agricultural production through the establishment of simple water retention structures. The management options are very site specific, adding to the complexity of the upland ecology. Therefore, although NARS have a comparative advantage in taking a leading role in research on this ecosystem, their capacity to undertake water management research, as far as rice is concerned, is weak. Therefore, *the Panel suggests that WARDA facilitates training for NARS and other players at local level in water management so that research on the development of water conservation and water harvesting strategies can be conducted in the uplands and targeted rainfed lowlands outside the scope of the IVC.* Residue management or mulching to conserve water and suppress weeds; the use of seepage water, groundwater, small dams, bunds and other barriers to conserve rain water; and other soil and water conservation techniques, etc. are some options that may be considered for future research geared at intensification and diversification of these areas.

Much of the rice production area in Africa is in the uplands and rainfed lowlands (63 %, FAOStat, 2007). With the exception of irrigated areas (17%), the scope for increasing yields is much higher in the lowlands, due to water availability and relative good soil fertility with higher organic matter than in the uplands. Putting inland valleys into productive use remains a key strategy for increasing productivity of rice-based systems in Africa. The Center is responding to this challenge through IVC. However, although many projects are ongoing in this area, national IVC partners are weak in water management expertise. Moreover, the ecological values (changes in hydrology and biodiversity, wetlands functions and carbon sequestration) of inland valleys are still poorly understood and may be damaged when they are put into intensified use (e.g.

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<sup>73</sup> Häfele, S., M.C.S. Wopereis, C. Donovan and J. Maubuisson. 2001. Improving productivity and profitability of irrigated rice production in Mauritania. *European Journal of Agronomy* 14(3): 181–196.

<sup>74</sup> Becker, M. and D.E. Johnson. 2001. Improved water control and crop management effects on lowland rice productivity in West Africa. *Nutrient Cycling in Agroecosystems* 59(2): 119–127.

<sup>75</sup> CCER on Integrated Genetic and Natural Resource Management, WARDA, Cotonou, 2006.

changes in organic carbon dynamics caused by drainage). Therefore, the *Panel suggests that the capacity of IVC partners, including the national coordination units (NCU), to conduct water and soil research and spatial analysis be strengthened.*

Water management research is concentrated on irrigated areas where rice yields, productivity and profitability are relatively higher, but irrigated lowlands only represent 11% of the rice the area and 26% of production in Africa. However, even St. Louis, the outstation where water research is concentrated, does not presently have a permanent water management/irrigation specialist. WARDA's national collaborating partners also lack capacity in water management (for example critical mass on water management in the NARS of Senegal, Mali, Mauritania and Uganda at the time of Panel visit was very low) but irrigation systems in those countries are faced with low irrigation efficiencies and problems of water delivery at system and farm levels. Research issues may include water crop modeling approaches, water irrigation scheduling, strategies to improve rice yields, efficiency and organization and management aspects of institutions responsible for water delivery and maintenance of the irrigation scheme (e.g. Office du Niger, Mali and SAED, Senegal), crop management strategies to save water, hydrology aspects of rice production and land use planning (to identify the most profitable and sustainable rice-crop rotations in those irrigation schemes or in the rainfed lowlands). Moreover, research on policies and institutional issues such as the organization and management of the institutions responsible for water delivery to rice farmers; how they link with research and other actors of the value chain; how the water price affects the profitability of rice, etc. need also attention. In addition, training of farmers and irrigation farmer organizations, and development of improved water management and distribution beyond the secondary irrigation canals in the major West Africa rice irrigation systems, is needed.

The Panel commends WARDA for the inclusion of water saving strategies and environmental aspects in the Center's research agenda for the irrigated lowlands – which are the most susceptible for environment degradation. Although, work on water saving strategies and collaboration with IRRI are already *ongoing at the WARDA St. Louis station (involving a Dutch junior scientist)*, the *Panel suggests that the collaboration on improving water productivity and the development of water saving strategies be strengthened, possibly with increase involvement of IWMI scientists.*

The scientific achievements in water management are very good if we consider that after the departure of one IWMI seconded scientist based in M'bé in 2000 and another based in St. Louis in 2001, WARDA had no water management specialist due to lack of financial resources. Although the Panel was informed that a water management position was created and the process of filling the vacancy is underway, it is the Panel's view that this situation is very critical, and urgent corrective measures need to be taken. In addition, since there is need to concentrate in both the irrigated areas and rainfed lowlands, WARDA needs to define water management as a Center core research area and one scientist may not be enough. Therefore, the *Panel recommends that WARDA: (1) recruit without delay two scientists, in irrigation engineering/hydrology and in crop-water modeling/land use-planning, respectively; (2) develop a strategy to mainstream water management research into the Center's core research program; and (3) help strengthen the capacity of national organizations for conducting research on the rice-water-soil interfaces, in collaboration with IWMI and other relevant partners.*

### 2.3.3. Pest and diseases management

Research on pests and diseases is designed to find both integrated pest management (IPM) and breeding solutions to major problems such as Rice yellow mottle virus (RYMV), African rice gall midge (AfRGM), and blast and stem borers (detailed list constraints per rice ecology is given in Table 2.1). Considerable progress has been made to control both AfRGM and RYMV through IPM. Moreover, through the screening of the genebank materials, genes for resistance to major diseases and insect pests such as RYMV, AfRGM, bacterial leaf blight (BLB) and blast are now available (WARDA Strategic Plan 2003-2012, p. 32). Nevertheless, work on the identification of the mechanisms associated with resistance/tolerance to AfRGM in *sativas*, *glaberrimas* and NERICAs, genetic fingerprinting, and an integrated approach combining host plant resistance and biological control of AfRGM, identification of the genetic bases and mechanisms of resistance/tolerance of major pests and diseases is ongoing. Except for RYMV, progress has been slow, probably due to lack of critical mass.<sup>76</sup>

The work on RYMV and AfRGM is complemented by studies on the search of high yielding rice varieties with stable tolerance or resistance to blast, BLB and stem borers. While much progress has been made on the characterization of blast genetic diversity, characterization of pathogen diversity, screening sites, and potential host resistance<sup>77</sup>, varieties with stable resistance are not yet available. This is due to high blast pathogen variability, which is hindering efforts towards development of blast-resistant cultivars adapted to local agro-ecological conditions.

Rice and maize share some common stem borer species. For that reason, in collaboration with IITA and ICIPE, WARDA is exploring the possibility of using maize stem borer natural enemies on rice. In addition, some progress has been made in the identification of upland NERICAs with resistance or tolerance to stem borers in West Africa.

In collaboration with the IITA biotechnology unit, molecular characterization of new gall midge species and AfRGM biotypes from different African countries has been made using molecular tools. Bio-pesticides for termite control of both soil and foliage pests, and options for post-harvest storage management have been developed. Most of this collaboration work is supported by the mass rearing facility at Abomey-Calavi University, Cotonou and the IITA biodiversity resources centre where WARDA maintains a reference collection of insects from different countries, and provides services for NARS scientists, students, NGOs and farmers in Africa. Collaboration with IITA has resulted in an integration of varietal resistance and cultural practices utilizing natural enemies (egg and larval parasitoid and pupal parasitoid) to control AfRGM damage. By managing the habitat for natural enemies around the edge of rice fields, the carryover of AfRGM parasitoids onto rice can be increased. *The Panel suggests that the efficacy and impact of this integrated AfRGM management need be evaluated on-farm. In relation to the*

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<sup>76</sup> Ahmadi, Nourollah and Alastar William Orr, Creating Low Management Plant Types for Resource-Poor Farmers in Rainfed Ecosystems Project, WARDA, Monitoring of CGIAR Projects Co-funded by the European Commission in 2003 in Asia, Latin America and the Mediterranean Regions, ECART-NATURA, Brussels, December 2004, 21 p. + annexes.

<sup>77</sup> Sere, Y., Sy, A.A., Akator, S.K., Onasanya, Z.. and Zai, K.. 2004. Screening strategy for durable resistance to rice blast at WARDA. pp. 38-42. in Sere, Sreenivasaprasad and Nutsugah (eds.). Rice blast in West Africa: Characterisation of pathogen diversity, key screening sites and host resistance. Proceedings of a stakeholder workshop, Project R7552, UK Department for International Development - Crop Protection Programme. Africa Rice Center WARDA Bouaké, Côte d'Ivoire, vi + 152 p.

*SC issue 8 on integrated pest management*, the above discussion indicates that the WARDA/IITA collaboration on insect pests of rice is effective, and is expected to produce useful results.

Research on pest and diseases management is well focused, and considerable progress has been made to control pests and diseases through breeding and integrated pest management. The evaluation under natural pest infestation and farmer participation in technology development is essential for improved impact of research. This includes consideration of cropping systems (e.g. rice mixed and strip cropping in uplands) and farmer participation in technology development as they may significantly increase research impact. The Panel was impressed with the level of current collaboration with IITA and ICIPE on integrated pest management, and commends all partners involved in this effort. Many promising and innovative new frontiers of research have been opened, such as in post-harvest management, and on the use of biological control measures for termites and stem borers, and also on the provision of services to a wider community. Given the growing importance of soil-borne pests on yield depression on the diverse and complex upland and rainfed lowland environments, *the Panel suggests that more attention be given to the development of IPM options for mitigating the impact of termites and soil-borne nematodes, especially in the uplands.* Because belowground diversity (BGBD) studies have shown that molecular methods can be used to define dominant microbial populations and monitor shifts within them in response to varying crop management practices, *the Panel suggests that WARDA explore these methods to monitor impact of crop management practices on microbial population structure and functions.*

#### **2.3.4. Weed management**

As noted above, weeds are a major constraint to rice production in the uplands and rainfed lowlands. In April 2001, the Weed Research unit merged with Cropping Systems Agronomy (CSA). Previous research in CSA at WARDA focused on two topics: a) yield gap analysis for upland and lowland systems; and b) improved fallows with cover legumes.

Yield gap analysis for upland systems identified weeds and soil fertility as the two major causes for low rice yields. For lowland systems, the reasons for low yields were more diversified, and depended on input use efficiency and management, but again weeds and soil fertility were major factors. Studies have shown that improved fallow systems have a positive effect on weed suppression, but adoption by farmers on WARDA's key sites (Gagnoa, Danané and Boundiali in Côte d'Ivoire) was limited, and one year later, the on-farm trials were terminated. Mainly because of this experience, it was decided to orient research efforts on weeds in upland systems towards the investigation of the response of rice varieties to competition with weeds. For lowland systems, research has focused on improved management options and the response of rice varieties to competition with weeds.

Following the development of inter-specific lines (NERICAs), weed research was almost entirely geared to improving and testing weed-competitive ability of varieties. Rapid vegetative growth and leaf-area development, and droopy lower leaves during early growth stages are the traits that can confer weed-competitiveness of varieties. For this reason, the new inter-specific hybrids between *O. glaberrima* and *O. sativa* varieties have created high expectations for better weed-competitiveness of rice varieties in Africa. Indeed, Futakuchi and Jones (2005)<sup>78</sup> have shown that under lowland conditions, some interspecific hybrid lines show these vegetative growth traits.

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<sup>78</sup> Futakuchi K and Jones, MP. Japan. J. Crop Science, 2005, Vol. 74 extra 2: 260-261.

Haefele et al. (2004)<sup>79</sup> tested 25 cultivars and lines including interspecific hybrids and showed that yield losses due to weeds were up to 84%, suggesting the potential to improve weed competitive ability of the existing varieties by means of interspecific hybridization. In their study, however, the plant traits that appeared under weed-free conditions did not explain the varietal differences in the weed-competitive ability. This suggests that the evaluation of the varieties/lines for weed competitiveness should be done under weed pressure. In this regard, the evaluation of NERICAs for their weed competitiveness needs experimental confirmation. *The Panel suggests that the screening method under competitive pressure in the irrigated lowland ecology proposed by Haefele et al. (2004)<sup>80</sup> may be utilized for the evaluation of the existing varieties and can be extended to the rainfed lowlands.*

Other studies in the uplands include those on the effects of host plant genotype on reproduction of the parasitic weed *Striga hermonthica* and characterization of host tolerance.<sup>81,82</sup> Ongoing work has identified the weed *Rhamphicarpa fistulosa* as the main constraint to rice production in the inland valleys of Benin. Work is ongoing at WARDA HQ to devise control measures for these newly identified weed.

*However, the improvement of varieties' weed-competitiveness alone cannot protect rice from yield losses due to weeds, notably in the upland and rainfed conditions.* A combination of effective weeding methods that can be afforded by the farmers is essential. In the irrigated lowlands, flooding plays a major role in weed suppression, and farmers can afford chemical measures to control weeds. The Panel has found evidence of studies to determine adequate timing and efficacy of weeding<sup>83</sup> and the interaction of soil fertility and weeds<sup>84</sup> under irrigated lowland conditions. Research has also devised management options. Ongoing work seems to suggest that some lowland NERICAs (e.g. *NERICA 31* and *32*) are more weed-competitive than their *IR 64* (*sativa* parent), *CG 14* (*glaberrima* parent) but since only one year data is available the experiment continues so that firm conclusions can be reached. While an analysis of peer-reviewed papers between 2000 and 2006 shows that the share of weed management papers published is only 4%, the papers are of very good quality. It is the Panels opinion that the scientific output is good if we consider that the Center has no senior weed scientist since 2001. More recently, it has recruited a weed scientist to be based in St. Louis. The Panel wishes to commend WARDA for that recruitment but is of the opinion that more attention should be given to the uplands and rainfed lowlands, where weed pressure is greater than in the irrigated environment because farmers in irrigated areas already have at their disposal weed management options and water help to suppress weeds. Therefore, on the *SC issue 8 - What is the progress on*

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<sup>79</sup> Haefele et al., *Field Crops Research*, 2004, Vol. 88:39-56.

<sup>80</sup> Haefele SM, Johnson DE, Mbodj D, Woperies MCS and Miezani, KM. *Field Crops Research*, 2004, Vol. 88:29-46.

<sup>81</sup> Rodenburg J, Bastiaans L and MJ Kropff. 2006. Characterization of host tolerance to *Striga hermonthica*. *Euphytica* 147, 353-365. <http://dx.doi.org/10.1007/s10681-005-9030-2>.

<sup>82</sup> Rodenburg J, Bastiaans L, Kropff MJ and A van Ast. 2006. Effects of host plant genotype and seed bank density on *Striga* reproduction. *Weed Research* 46, 251-263.

<sup>83</sup> Johnson DE, Woperies MCS, Mbodj D, Diallo S, Powers S and haefe SM. Timing of weed management and yield losses due to weeds in irrigated rice in the Sahel. *Field Crops Research*, 2004, Vol. 85:31-42.

<sup>84</sup> Häfele S, Johnson DE, Diallo S, Wopereis MCS and I Janin. 2000. Improved soil fertility and weed management is profitable for irrigated rice farmers in Sahelian West Africa. *Field Crops Research* 66(2): 101-113.



*weed management as a major limiting factor for improving labor productivity?*, it is the Panel's view that considerable progress has been made in the irrigated lowlands where most research was conducted and farmers can afford chemical measures for weed control. In the uplands and irrigated lowlands, the management of weeds is more important than in irrigated areas, and more could have been done for developing and dissemination of weed management options to farmers (e.g. socioeconomic considerations for previously developed options). Therefore, *the Panel recommends that WARDA develop, in collaboration with weed scientists from advanced research institutions, a strategic vision for future research in weed management, and revisit its decision to focus almost entirely on the expected weed competitiveness of NERICAs*. This should also include the definition of the elements of the integrated weed management approach (not only relying on weed competitiveness), the identification of research foci in terms of rice ecology and strategy for the testing of crop weed management options at the regional and local levels (SC Q8).

### **2.3.5. Genotype-environment interactions (G x E) and implications for priority setting**

Crop and soil fertility research at WARDA is based on prior identification of nutrient deficiencies in major agro-ecological zones (AEZs) in West Africa. This approach of adjusting research objectives to major AEZs may be appropriate for exploratory work, to look at the regional "big picture" (synoptic view). This has to be followed and/or complemented by "zoom-in" work in targeted areas.

Currently, WARDA's water, pests and diseases management research is based on rice ecologies, which may not capture well the whole complexity and diversity of the hydrological continuum (from the uplands to the irrigated lowlands). Indeed, most crop management results have shown significant genotype by environment (G x E) interactions for yields in multi-location yield trials. For example, five intermediate yield soil fertility trials conducted across sites in Nigeria, Mali, and other countries clearly showed that genotype selection must be location specific (CCER on IGIRM). These differences are mainly because there is still considerable heterogeneity within AEZs and rice ecologies. For example, differences exist in climate (rainfall, temperature and evapotranspiration), hydrology, soil type and soil fertility, and socio-economic conditions, which often may outweigh differences in genotype-based responses. There is therefore a diversity of microenvironment niches. In addition, in order to improve the efficiency and effectiveness of research activities -- the likelihood of finding a solution, e.g. for biotic and abiotic stresses, and improve the adoption of technologies -- there is need for stratification of the biophysical and socio-economic environment into smaller "homogenous" units (microenvironment niches) to be targeted by research. As explained below, homogeneous units can be identified by using GIS-based spatial analysis tools.

Obviously, depending on the objective of research activities, an intervention can be at any level, but the appropriate level is often easier to identify when researchers already have in mind the different levels where solutions are needed (regional, AEZs, ecology, microenvironments, etc.). In addition, prior to conducting the research, a strategy should be designed so that research activities at one level complement those at other levels. In other words, solutions for specific microenvironments can be integrated and generalized for AEZs and regions, but not the other way around. For example, uniform methodologies, experimental design and protocols, soil determination methods, etc. are needed in experiments across locations to reduce confounding factors and improve the integration of multi-locational trial results. This means that appropriate

strategies for harmonization, information exchange and dissemination of research results also need to be in place.

Remote Sensing (RS), Geographic Information Systems (GIS), and Geopositioning Systems (GPS) are powerful tools that can enable stratification through spatial analysis. Most of the expertise, information and products are available in the GIS unit at WARDA, and some RS data is available within project 6 – Mitigating human and environmental effects on rice-based livelihoods. Other soil-, water-, climate data can be obtained through AGRHYMET (for the Sahel), FAO and IWMI, while socio-economic data may be available through IFPRI. RS data now available include RS climatic data (Evapotranspiration, etc.), biophysical and socio-economic information stored in WAIVIS. Land degradation, soil maps, etc. for the region are easily available. Ongoing work includes the development of NIVISA. Other decision support tools such as RIDEV and FERRIZ could also be used for predicting cropping calendar and soil fertility aspects. All this wealth of information and tools used appropriately would result in the definition of homogenous units. Constraints to rice production in each of these units would be identified and quantified, allowing for improved research priority setting. Specific activities (breeding, NRM, socio-economics), for example testing and development of crop, soil, water management recommendations, would then be designed for each unit in collaboration with national research partners. Therefore, the *Panel suggests that GIS/RS and spatial analysis tools developed at WARDA and national coordination units of participating IVC countries, and other decision support tools be used for the stratification of regions and rice ecologies into more micro-level homogeneous units.* Interdisciplinarity is essential for improving research efficiency in field activities. The roles and responsibilities for each discipline and researcher from WARDA, NARS and others, and strategies for bringing all parties together should be defined.

#### **2.3.6. Concluding remarks on agronomy and NRM research**

In conclusion, NRM research at WARDA addresses the main soil, nutrient, water, weed, pest and diseases constraints to rice production in West Africa. In the Panel's view, this work is relevant and of good scientific quality. Considerable progress has been made in developing and disseminating NRM technologies to farmers through NARS. The Panel's overall assessment and the areas needing further work are outlined below.

**Follow-up on NERICAs:** The mechanisms and processes behind NERICA's productive potential are generally unknown. The Panel suggests that follow-up studies on better understanding of *O. glaberrima* parents and NERICAs in terms of mechanisms associated with NERICA's superior performance e.g. higher nutrient-use efficiency, water-use efficiency and productivity, resistance to pest and diseases, protein content and weed competitiveness be done. It is important that the target trait be well defined, and progenies traits be examined agro-physiologically.

**Crop and nutrient management:** WARDA's research addresses the main constraints in the AEZs; and the work is relevant and of good scientific quality. Excellent work has been done in cropping systems and nutrient management that has led to the identification of profitable crop rotations and combinations, the development and dissemination of best-bet technologies in cropping systems and nutrient management, and in understanding the processes and mechanisms of nutrient cycles of NPK, iron toxicity in inland valleys and soil salinity in irrigated areas. Although WARDA has been successful in developing varieties adapted to poor environments, practical evidence from the field has demonstrated that NERICAs yields decline after a couple of years if nutrients are not added. Therefore, future work in this area should be

geared at finding strategies to improve the productivity and sustainability of rice cropping systems. Moreover, attention should be given to developing and using advanced methods and concepts for nutrient management such as organic carbon turnover in soil and fluxes within soils and across ecosystems, the use of spectroscopy techniques, GIS, RS and GPS for quick inventories of soil salinity and soil analysis, below-ground interactions in rice ecosystems using molecular techniques, impact of rice production on soil quality aspects (soil stability and particle size fractions), among others. WARDA's agronomy and soil fertility unit should also seek closer collaboration with CIAT-TSBF and other advanced research institutions.

**Water management:** Although of good quality, very little work has been done on water management. In view of the current water scarcity and competing demands between agriculture and other uses, there is a need to develop water-saving strategies, and to improve efficiencies in the irrigation systems and in crop water use, as well as water productivity in general. In addition, water delivery systems at irrigation system and farm levels, the effects of water prices on rice productivity and farmer organizations and management aspects in the irrigation systems need attention. A combined approach (modeling and experimental) is suggested, because of the various and complex rice-water-soil interactions. Furthermore, capacity in water management at WARDA and NARS needs to be strengthened.

**Weed management:** Some progress has been made in terms of developing weed management options for irrigated areas. However, weeds are a bigger problem in the uplands and rainfed lowlands, and weed management technologies that can be adopted by farmers are very limited. Furthermore, because varietal improvement for weed-competitiveness alone cannot protect rice from yield losses due to weeds, there is need to develop combined ICM-breeding strategies for future research in this area.

**Integrated Pest Management:** Excellent work on IPM has been done, especially in options to control blast and stem borers, in collaboration with IITA. However, further evaluation of these strategies under natural pest infestations, as well as farmer participation in technology development is essential for achieving better results. The Panel was impressed with the level of current collaboration with IITA and ICIPE on IPM and suggests that this partnership be strengthened and expanded, for example including research on soil-born nematodes, termites and other explorations of the impact of rice management practices on microbial below ground biomass using molecular techniques, in collaboration with advanced research institutes. Many promising and innovative new frontiers of research have been opened, such as in post-harvest management, and the use of biological control. These need to be pursued further.

**Stratification and implications for priority setting:** Because most crop management results have shown significant G x E interactions for yields in multi-location yield trials, modeling, decision support systems, and GIS/RS tools already available at WARDA, can be used to improve priority setting through stratification of the AEZs and rice ecologies into "homogenous" (biophysical and socio-economic) areas. This will enable better research targeting and dissemination of research products, will improve research efficiency, and will thereby increase the chances of adoption by rice farming communities.

**Communication and visibility of NRM research:** Although the Center focuses more on genetic improvement than NRM, considerable progress has also been made on NRM research, and in developing and disseminating NRM technologies to farmers. However, this is not the impression most people get when WARDA communicates its achievements. For example, the summary of

WARDA's achievements (2000-2006).<sup>85</sup> The Panel suggests that WARDA improve the visibility, documentation and communication of its NRM achievements, and put greater focus on NRM research, so that rice production can be sustained over time.

## **2.4. Social sciences at WARDA**

This section discusses social sciences research at WARDA, except for adoption and impact studies, which are discussed in Chapter 5.

### **2.4.1. Social sciences research achievements over the period 2000 - 2006**

Over the period 2000-2006, the main research achievements are:

- Nigeria rice sector policy review
- Impact of trade liberalization on the rice sector of Côte d'Ivoire
- Policies and institutional arrangements for irrigated rice in West Africa
- The ASI thresher: adoption and impact
- Software tools for impact assessment
- Enhanced capacity of NARS in impact assessment

These will be reviewed briefly hereafter. Impact assessment research is discussed in chapter 5.

#### **2.4.1.1. Production Economics Research**

The major achievements of production economics research at WARDA are the following: Profiles of production systems along the lowland-irrigated continuum (Senegal, Gambia, Mauritania, Burkina Faso, Togo, Ghana, Nigeria); generation of farm management database (Senegal, Burkina Faso, Gambia); identification of scope for improving resource use efficiency (Senegal, Gambia, Mauritania); ICM and the evolution of productivity gaps (Senegal, Gambia, Mauritania, Burkina Faso); assessment/development of harvest/post-harvest technologies (Senegal, Mali, Burkina Faso, Mauritania, Ghana); and training of students at the University of St. Louis (Senegal).

#### **2.4.1.2 Technology Transfer Research**

Participatory tools utilized by WARDA facilitate not only the understanding of socioeconomic factors for better uptake of proven agronomic technologies, but also help improve and package given technologies in a proactive way. Major participatory tools that WARDA has used in technology transfer and participatory research are the following:

#### **Participatory Learning and Action Research (PLAR)**

Based on successes in irrigated rice systems in the Sahel, WARDA developed in 2001 its own method called Participatory Learning and Action Research (PLAR). The Panel commends WARDA for developing PLAR. The thrust of PLAR is to facilitate technological and organizational change through improving farmers' capacity to observe, to exchange knowledge, experiences and practices, and to make better-informed decisions. By 2005, four years after its

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<sup>85</sup> Achievements since the Fourth EPMR, WARDA, March 2007.

development, PLAR had been introduced in Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Madagascar, Mali, Nigeria, Gambia and Togo.

### **Participatory Varietal Selection (PVS)**

This is discussed in the chapter on genetic improvement.

### **Community-Based Seed Production Systems (CBSS)**

This is discussed in 5.6 on Institutional innovations in seed systems.

#### **2.4.1.3. Post-harvest Activities**

Between 2001 and 2005, WARDA's Technology Transfer Unit undertook post-harvest research activities to some extent. However, these have been mainly limited to capacity building of local blacksmiths, and on-farm evaluation of thresher-cleaners and improved parboilers. In 2005, in collaboration with governmental and non-governmental partners, videos were developed with women rice processors to illustrate an improved method of rice parboiling.

#### **2.4.1.4. Sociology/Anthropology Research**

The sociology/anthropology research component at WARDA is incipient. With the recent recruitment of a sociologist from Cornell University, and the projected tripartite institutional arrangement (University of Pennsylvania, State University of Missouri, and WARDA) a new momentum has been created for more systematic sociology research being undertaken at WARDA in the years to come.

#### **2.4.1.5. Market and Policy Research**

The focus of market and policy research rests on two main research questions: (i) What factors affect rice price and market dynamics, and how these factors affect the competitiveness of rice in West Africa; and (ii) what are the impacts of technological, policy and institutional changes in the rice sector on the livelihoods and wellbeing of the poor. To support policy and market research, WARDA set up a West Africa Rice Statistics Data Bank, and published its first edition in 1996 as *Rice Trends in West Africa (1972-92)*. The third edition, which was published in 2005, is titled as *"Rice Trends in Sub-Saharan Africa"*. It summarizes trends in rice production, consumption and trade in 52 countries of SSA. The following three important research outputs in the area of Market and Rice Policy merit special mention:

#### **Rice Competitiveness Study**

Country studies were developed using the Policy Analysis Matrix (PAM), a methodology developed by Stanford University and the University of Arizona to assess net effects of policy, competitiveness and comparative advantage of agricultural systems. The seven countries analyzed were: Côte d'Ivoire, Nigeria, Niger, Mali, Senegal, Guinea, and Sierra Leone. Recently (2004), the Guinea rice sector competitiveness study was also completed using the PAM approach.

## **The Nigerian Rice Sector Policy Study**

This work resulted in the production of a range of research reports, and a strategy to revitalize the Nigerian rice sub-sector, all of which were presented at a workshop ('Stakeholders Forum') in September 2003. To a large extent, the proposals focused on issues of rice quality, and on how this affects the comparative consumer acceptability of local and imported rice, (local rice was being discounted by around 30% *vis-à-vis* imports, mainly because of a lack of cleanliness). WARDA's and NISER's research findings focused on quality and branding as a source of competitiveness. This work led to the creation of the country's Presidential Initiative on Rice, which has been raising awareness of the issue throughout the nation, the legalization of private fertilizer imports, the high import duty and levies (over 100%) on imported rice and the subsidies on seeds (50 %) and fertilizers (25 %).

## **Multi-country Policy Study**

A multi-country study on policy and institutional effects on rice production and marketing in West Africa was initiated in 2005. The data collection, which consisted of village level and household surveys, is now complete and has been systematized into a database with data on Burkina Faso, Mali, Niger and Nigeria. In June 2006, a five-day review and planning workshop was organized in Cotonou with NARS partners to finalize data check and ensure quality before embarking on data analysis.

### **2.4.1.6. Workshops**

#### **Rice Policy and Institutional Arrangements in West Africa**

A policy study methodology and planning workshop was held from 2 to 4 May 2005 in Cotonou, Benin. Participants from Burkina Faso (2), Mali (2), Niger (1), and Nigeria (2), including WARDA staff attended the workshop. The workshop provided an opportunity for participants to discuss current policy and institutional situation of their countries. The experts agreed to the formation of a rice policy research and advocacy platform at the regional level, as a channel for transmitting policies to promote the rice sector in the region. The network is to be known as Agricultural Policy Research and Advocacy Group (APRAG).

#### **SSA Regional workshop on Rice Policy and Food security**

WARDA held a three-day workshop from 7th to 9th of November 2005, in Cotonou, funded by the Canada Fund for Africa. The workshop was attended by over seventy participants from 16 countries. The final plenary session translated the results of the discussions into resolutions/recommendations, synthesis, and commitments for the way forward.

### **2.4.2. Core research challenges**

WARDA sees its core research challenges in social sciences research (SSR) as:

(i) Integrated Production Systems: How best should existing genetic resources be used to develop rice varieties that best fit or better optimize farmers' existing production systems and are acceptable to both producers and consumers? How can resource use efficiency be further increased for more productive, profitable and socio-economically viable rice production systems? and

(ii) Rice Policy and Development: What factors affect the price of rice and market dynamics, and how do these in turn affect the competitiveness of local rice production? What impacts do technical (adoption of technologies), policy and institutional changes in the rice sector have on the livelihoods and well-being of the poor?

In 2000-2001, as a follow-up to the recommendations of 4th EPMR, the then Program 3: Policy Support and 4: Systems Development and Technology Transfer, were merged into a new Program 2 titled "Rice Policy and Development Program". The social scientists at WARDA form a thematic group, with an elected thematic group leader. The present cadre of the thematic group, and the positions filled, is shown in Table 2.2 below.

This (new) Program 2 on Rice Policy and Development draws from the Center's successful experiences. It highlights the importance of the participatory research approach; appropriate policy and market environment for the rapid uptake of improved technologies; and impact assessment studies on productivity, profitability and poverty in the realm of rice sector. The thrust of Program 2 is on (a) building strategies for competitive rice sector development in SSA through a better understanding of rice policy and market dynamics; and (b) assessment of the impact of technical, policy, and institutional changes within the rice sector. The program functions through a set of well-focused projects with specific outputs and milestones within the MTP. The emphasis is on production-based systems; and socio-economic research issues that cut across productions systems and can be addressed through an integrated approach.

Rice policy and development research needs to be well focused, as this is a very broad area. Only a well-focused approach, as was done in the Nigerian rice sector policy study, can produce tangible results and impact. Moreover, as suggested in the EC report in 2005 regarding institutions, a results-oriented focus is needed to identify what works, what does not and what new approaches should be tried.<sup>86</sup> This involves action-research whereby the research team accompanies ongoing development initiatives and feeds back lessons. The team should compare situations across countries, which will provide a wealth of insights to the research process. It is important that the outcomes of SSR on production systems and adoption of technologies, including non-adoption and disadoption, feedback to technology development at WARDA, e.g. variety development. The Panel concurs that these research foci are appropriate. However, what seems to be missing is ongoing *ex-ante* impact assessment for priority setting of research, although this has been done in preparation for the SP 2003-2012.

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<sup>86</sup> Jonathan Coulter and Bohumil Havrland , "Policy Environment and Rice Market Development" project 3.2. (Project 5) for the European Commission, November 2005.

### 2.4.3. Social Science research team

The cadre of social scientists and the positions actually filled are shown in Table 2.2, below:

Table 2.2 Social science research team at WARDA						
Positions	Senior cadre	Position filled	Postdocs cadre	Position filled	Research assistants	Visiting scientists
Economists						
- production economists	2	1	1	-	2	
- policy economist	1	-	1	1	1	21
- impact assessment econ.	1	1	1	1	1	
Sociology/anthropology						
- tech transfer specialist	1	1	1	1	1	2 PhDs
- gender specialist/HIV	1	-2			1	
- sociologist	1	-			1	

1 Only for a limited period in time

2 Temporarily filled by a consultant

Source: WARDA

This cadre, with the positions filled, appears adequate to the Panel. The EPMR benefited from a CCER on social science undertaken in June-July, 2006. This report is, in general, quite helpful; but its main recommendation that the team should be expanded to include two production economists, two policy economists, two sociologists and one each of technology transfer scientist, impact assessment economist, marketing and trade economist, and resource economist, ten IRS positions in total, is not very realistic -- taking into account WARDA's overall budget, the needed balance between disciplines, and the need for operating funds for each scientist.

At the time of the current EPMR, WARDA's cadre and filled positions are as shown above in Table 2.2. Two economists separated from the Center in February 2007. Two positions are vacant and published: a policy economist, and a production and resource economist. Some of these positions of agricultural economists have been vacant for well over two years. The first recommendation of the social science CCER was to fill the vacant positions immediately and to take the necessary steps to avoid situations of positions remaining vacant for a long time in the future. We agree with that recommendation. In its response, WARDA also recognized that the delay in recruiting core staff in social sciences led to discontinuity in some SSR activities. The question of vacant positions stems from the 2002 Côte d'Ivoire crisis following which the policy economist, the technology transfer scientist and later the upland production economist all left the Center. What is also apparent is the difficulty in recruiting competent agricultural economists at WARDA, from either the region or elsewhere. Thus, the main issue in social sciences at WARDA at the time of the EPMR is that of critical mass in agricultural economics, which is seriously deficient.

The gap is particularly evident in the senior economist's positions. It is clear that the research program in economics has suffered from this. Nevertheless, through the ROCARIZ/ECARRN research network, and particularly the economics task force and the APRAG, economists from the region work together with WARDA on the research agenda. In impact studies, 12 NARS are currently involved with WARDA; on irrigated rice policy studies, 6 NARS are currently involved; on post-harvest, 5 NARS are currently involved. Common methodologies are used, with questionnaires and survey designs, and sharing of analysis tools. This implies methodology



learning workshops and training on-the-job by scientists from WARDA. Professors and Ph.D. students from SSA universities, either virtually based at their universities, or as short-term visiting scientists/sabbaticals also contribute to WARDA's research program. However, the lack of critical mass in place at WARDA seriously constrains effective collaboration with agricultural economists in the NARS. A large team of economists in the NARS, even if they are working on WARDA's core research challenges, can only partially compensate for vacant positions at WARDA itself.

#### **2.4.4. Assessment**

The Panel concurs with the 2006 CCER on SSR that the social scientists have been doing excellent work to fulfill the objectives of the Center and the CGIAR. The SSR activities and outputs should be feeding directly into the technology generation process, and be helping in dissemination of technologies and be instrumental in shaping a favorable rice development policy environment. This seems to be lacking, as the integration between technology developers, particularly breeders, and social scientists, leaves much to be desired. Integration and feedback, particularly regarding adoption and yield impact findings, appear inadequate. This is further discussed in the adoption and impact chapter. The Panel also feels that had the positions of production economist, policy economist and sociologist not remained vacant for so long, the contribution of the SSR unit could have been much more.

Presently, it is planned for future SSR at WARDA to focus on: functioning of seed systems; post-harvest technologies and systems; trade policy options to counter subsidies in exporting countries; NERICA impact assessment; strategy to improve the influence of policy research on the policy making process. The Panel believes this planned focus of SSR is appropriate; and the ongoing and planned research activities are relevant to, and consistent with the objectives of the Center and CGIAR. The quality of research output is also satisfactory.

The main issues are thus one of critical mass because of unfilled positions, and feedback to the technology generation programs and the policymakers through the COM and NEC. This has seriously affected the strength and effectiveness of the SSR program at WARDA. Feedback to technology development is an issue, because adoption is a complex process, is location-specific and because the environment and the farmers themselves are heterogeneous. Thus, social sciences need to be mainstreamed in WARDA's technology development programs.

*Because of research gaps in the social sciences research program (policy analysis, rainfed production economics, adoption studies), the Panel recommends that WARDA recruit a rural sociologist and fill other positions in the social sciences (production economist, policy economist) in a timelier manner.*

#### **2.5. Training and capacity building**

Training and capacity building needs to be an integral part of the research program, particularly since many NARS are still weak and lack human capital.

Training activities include both formal and informal training for groups and individuals. Strengthening capacity through use of a variety of training modules falls within the strategy of the Center to have tangible impact in Africa. Since its inception in 2002, the Training, Information and Library Services (TILS) has implemented a number of training modules for farmers,

students, scientists, extension workers, NGOs, development projects and other organizations. Participants were from various countries in SSA and partners and investors. Summary data illustrating the magnitude of training at WARDA during 2002-2006 is provided in Table 2.3 below.

<b>Table 2.3 Short Courses and Individual-level Training Activities at WARDA (2002-2006)</b>		2002	2003	2004	2005	2006	Total
Group training	Number of courses	6	7	4	12	5	34
	Number of participants	108	91	183	244	61	617
Individual training	Degree						
	Male	5	14	15	29	13	76
	Female	2	2	2	13	6	25
	Total	7	16	17	42	19	101
	Non-degree						
	Male	3	3	3	2	0	11
	Female	1	1	1	0	0	3
	Total	4	4	4	2	0	14
Total number of people trained		119	111	204	288	104	746

Source: Achievements since the Fourth EPMR, WARDA, Cotonou, March 2007.

The recently completed Science Council-commissioned study that evaluated training in the CGIAR and its impact provides additional information on Training at WARDA, as shown in Table 2.4 below.

<b>Table 2.4 Number of persons trained by WARDA 2001-2006</b>							
<b>Nature of training</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Total</b>
<b>Visiting Scientists</b>	7	6	1	1	1	2	18
<b>Ph.D.</b>	5	8	8	17	10	7	55
<b>Masters</b>	9	16	12	9	38	25	109
<b>BS and lower</b>	10	22	12	9	9	10	72
<b>Total</b>							247
<b>Non-degree/short term</b>							125
<b>Farmers</b>							335

Source: Elliot Stern, Lucia de Vaccaro and John Lynam, Evaluation and Impact of Training in the CGIAR, Science Council Secretariat, Rome, July 2006.

As expected, WARDA trains predominantly nationals from its Member countries. A major effort has been put on training of NARS scientists in molecular techniques. During the field visits, the Panel received requests for training in post-harvest technologies, rice grain quality and other areas. NRM training, particularly on soil and water management, needs attention in the future. In addition, more and better linkages with higher education institutions in SSA should be sought, including linkages contemplating outsourcing of training activities for NARS.

### 2.5.1. Training of NARS scientists in molecular techniques

The Cotonou laboratory acts as a training and operative center for NARS scientists in molecular marker technology. It is necessary that every country possesses the research capacity in molecular techniques to identify and adapt technology to its own needs and constraints.

Therefore, eight scientists from Burkina Faso, The Gambia, Guinea and Mali attended two weeks of intensive hands-on course training in molecular techniques to prepare them in generating, analyzing and presenting data from different molecular markers. The training included all steps from DNA extraction up to data analyses for genetic diversity studies, linkage mapping, QTL analysis, and MAS. Equipment necessary for DNA extraction, PCR reaction, migration of amplified products and gel documentation were purchased and sent to the four countries. This is very commendable. The Panel agrees that it is essential for proper development and use of these techniques that simple operations be conducted locally, mainly because the technology has evolved towards more simplicity and does not require complex equipment. Nevertheless, attention should be paid to possible logistical problems in the Member countries.

The Panel feels that the capacity building effort in this domain is developing well; and that the proposed plans are sound. The present focus is mostly on NARS scientists; but an important issue is who should be selected for training. Laboratory work is time consuming enough to have persons just dedicated to this activity; but the involvement of breeders is essential if one wants to see MAS fully utilized as a tool by NARS breeders. The Biotech Unit of WARDA also hosts students from sub-regional universities to conduct thesis research within the unit. The laboratory does not seem to be much involved with African universities, except through hosting students doing their research at WARDA, but the Panel does not see how it could go further in these collaborations without stretching too thinly its limited resources and losing its primary focus.

#### **2.5.2. The Post-Masters Internship Program**

WARDA plans to launch a new post-masters internship program for M.Sc. graduates of Africa from the Member States. Many M.Sc. graduates lack professional experience and have difficulty finding a first job; at WARDA, they will serve as research assistants, which are in short supply. The appointment would be for two years, non-renewable, at a salary comparable to that of entry-level positions in the public civil service. The plan is to recruit fifty of these per year, depending on the needs of each program and project, available budget, and requirements of the different locations where WARDA is operating. A condition for engagement will be the presence of senior scientists-supervisors. Through this original scheme<sup>87</sup>, WARDA hopes to attain better critical mass, while at the same time contributing to capacity building of the NARS. The recruitment will be through a public call, and the selection of candidates through a selection committee at WARDA. WARDA insists that the post-masters will not be a substitute for the recruitment of post-docs. The Panel endorses this innovative approach.

### **2.6. Research support**

#### **2.6.1. Farm development and operations**

WARDA manages research stations in Benin and Senegal, and is hosted by the research units of IITA in Nigeria (Ibadan) where the farm is managed by IITA, and Tanzania (Dar-es-Salaam) where WARDA just occupies an office from where it coordinates ECARRN but has no farm operations. Only farm development and operations are commented on below.

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<sup>87</sup> The director-general had already implemented such a scheme with success at ISRA, Senegal, where he was previously director-general.

### 2.6.1.1. Benin

Since 2005, WARDA established its temporary headquarters in Cotonou IITA station and is conducting its experiments there. The WARDA farm unit (2 permanent staff; 200 casual workers) is in charge of managing the greenhouses, the trial areas, as well as the demonstration plots and the varietal seed multiplication.

The land available for WARDA research on the Cotonou station is far from satisfactory. The farm unit was able to solve the water resource problem by a well/pump system. The available space, however, is too limited. WARDA has access to 15 ha land (compared with the 80 to 90 ha used in M'bé). This is already insufficient to set the planned trials (20 ha needed) and, *a fortiori*, to organize a serious crop rotation –which is absolutely needed since nematode problems have started to appear – for which at least double the amount of land is needed. Some research units/projects are using other more distant sites kindly shared by partners (INRAB in Benin, or IITA in Nigeria) and a large part of the activities are conducted in a decentralized manner in NARS partners' stations, or on-farm. Although partnership certainly helps to solve some of the space issues, it is essential for WARDA to be able to conduct experiments under well controlled conditions in a well managed station, without too much time lost in travel.

However, a reasonably satisfactory solution was mentioned to us that would consist in utilizing an old seed production farm of 62 ha, with its buildings, offered by the Benin government in Devé, 2 hours drive from Cotonou. The soil is good. WARDA's very competent farm manager seems confident in his ability to adapt the area to WARDA's needs. Squatters presently occupy the area but there is a possibility of overcoming this constraint.

The Panel is also concerned about the lack of trained personnel in the farm unit (only 2 permanent staff). Some very important farm operations, such as land preparation, are delegated to daily workers. The Panel understands the reluctance of WARDA's management to recruit permanent staff in Cotonou, because of the possible return to M'bé and the strict Benin labor laws, but hopes that compromise solutions can be found to ensure the availability of well trained staff for important operations. The WARDA-IITA alignment will induce large changes in the present situation in Cotonou and may put at WARDA's disposal trained staff and a large array of buildings, and may even provide some additional field space. However, plans regarding this are not yet finalized; the Panel is unable to comment further on this.

### 2.6.1.2. Outreach farm-operating stations

WARDA does research in countries other than Benin. An external consultant has prepared an Evaluation Report on Out Stations in 2007<sup>88</sup>. Quantitative data presented below are extracted from this report.

WARDA has been present in Senegal since 1989. WARDA's team in Senegal is large. The installations include a main station in N'diaye (4 scientists, 5 research assistants and 16 other staff) and a secondary station at Fanaye, in the Middle Valley, with 4 people. The Panel visited the main station (see report in Annex Xa). The CCER report concluded that N'diaye station buildings and science equipment were in an advanced state of deterioration and should urgently

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<sup>88</sup> Mohamadou El Habib Ly, Out Stations Evaluation Report, From Ibadan in Nigeria, to M'bé in Côte d'Ivoire, through Dar es Salaam in Tanzania and Saint Louis in Senegal, WARDA, 2007.

be restored. A research assistant has taken over the task of farm management as an additional responsibility after the 2005 retrenchment, which is not very satisfactory.

M'bé station is very well maintained with 4 Farm Unit permanent staff (36 staff are still based there). The Panel Chair visited the station, which is used for large-scale seed production (several hundred tons) but not anymore for experiments. In IITA station in Ibadan, where 4 scientists and their 15 staff are located, the situation regarding farm operations is good.

## **2.6.2. Genetic Resource Unit (GRU)**

The Genetic Resource Unit (GRU) handles around 17,000 accessions of *O. sativa*, mostly from West and Central Africa, 2,500 accessions of *O. glaberrima*, and 2,600 accessions of African wild species collected mostly in West Africa. The whole collection is located in M'bé genebank and represented in Cotonou, with a copy in IITA (Nigeria). It is being triplicated in Fort Collins, USA. An additional installation in Cotonou is being brought into service, funded by the World Bank and the Canada Fund for Africa, but is not yet fully functional (a germination room is still missing and a better generator needs to be installed).

GRU distributes small amounts of seeds of the genetic resources they have in stock. They shipped 2,967 samples in 2005, and 1,390 in 2006. GRU is in charge of genetic resource seed rejuvenation (done on an INRAB station; 2/3 of the collection has been rejuvenated in the 2003-2006 period). It is envisioned to rejuvenate the wild accessions that have not been tested for viability for a long time at IRRI, which has proposed to give access to their facilities. GRU takes care of phenotypic characterization during the accession rejuvenation and uses advanced experimental designs that enable the bridging of information across years. In collaboration with the molecular marker laboratory, it also does some molecular characterization of the accessions with microsatellite markers. New collections of landraces and wild species of *Oryza* will be undertaken in collaboration with IRRI and Cornell University since the project submitted to the Gatsby Foundation has just been accepted. The intellectual property issues linked to the signature of the International Treaty on Plant Genetic Resource for Food and Agriculture by the countries to be prospected (Kenya, Mozambique, Tanzania and Uganda), however, have not yet been completely solved.

GRU takes care of information management with four well-trained technical staff devoted full time to these operations. The GRU database including passport, pedigree and characterization data is accessible through internet since April 2007. The interfaces could not be tested at the time of our first visit. GRU benefits from support of CGNET, which primarily is hosting the database on its servers in the USA. The database specifications have been developed to be compliant with SINGER (Systemwide Information Network for Genetic Resources). GRU is also in charge of INGER Africa (see 3.1. and 5.1.2.).

The Panel commends the effort of GRU to set a working system for accession rejuvenation and characterization of the material in a scientific way. The Panel is very satisfied by the efforts to make detailed information available to the scientific community while respecting international standards. The Panel reminds WARDA's management that the role of a GRU is the conservation of genetic resources, which involves small-scale multiplication of a wide range of accessions, not the large scale multiplication of released lines for which the responsibility has to be taken by ARI.

### 2.6.3. Quarantine

All seeds shipped by WARDA-Cotonou (10 t/year), including INGER material, go through the Quarantine Unit before receiving the approval of relevant Benin officials. The seeds are fumigated and chemically treated against grain nematodes. The quarantine is the responsibility of WARDA's senior pathologist who manages the operation with his own research team; and there is no backlog, which shows good efficiency considering the large volume treated. As for other activities, the temporary location of WARDA at Cotonou has led to a decrease in staff number and in the kind of work that can be done at Cotonou station, primarily for testing the quality and purity of seeds.

### 2.6.4. Information and communication technology

The IT unit (4 permanent persons and ½ time temporary staff) ensures support for hardware, software, procedures, and staff training. The unit has already an integrated system with homogeneous professional hardware, common e-mail system, anti-virus and anti-spam systems, and data centralization. The unit is integrated in the overall CGIAR system that allows scale economy in software purchases (contract with Microsoft), and gets good support from CGNET (e.g. anti-spam, homing of GRU database, etc.).

Following the “Ivorian crisis” and successive relocations by the Center, emphasis has been put on system security, data storage, and archive reconstitution. An automatic back-up system has been put in place that requires some discipline from scientists in terms of file management. Two back-ups are routinely done, besides the local one: one in Benin, in the DG's house, another in Senegal. The Panel commends this effort to ensure proper data storage and possibilities of data recovery in case of major problems.

Concerning telephone and internet communications, the constraints for a landline are very strong in Benin where the national government-owned operator is not very efficient. The present system is not sufficiently fast and reliable for WARDA's research needs. Therefore, the option has been chosen to rely on an autonomous satellite connection. It costs US\$ 2,500/month for a 512 kb bandwidth. Nevertheless, the system is far from perfect since everything stops in case of a power cut which happens frequently. WARDA is not self-sufficient in terms of power supply (it depends on IITA). To get spare parts in case of problems takes a lot of time. It is the Panel's own experience that it is difficult to receive or send e-mails with attachments and that browsing the internet is a slow process. We do not think it can continue this way without hampering day-to-day work in WARDA, for both the administration and scientific teams, in a global world used to fast connections. To get equipment back-up would cost US\$ 25,000, and the needed extension of the bandwidth to 2.0 Mb an additional US\$ 8,000 per month.

Internet connectivity of the WARDA's station in St. Louis was said to have improved due to important investments recently made but is still not very good.

*The Panel recommends that WARDA makes the necessary investments and provide funds on a regular basis to ensure communications (e-mail and internet) that meet the performance standards expected at an international research institute, both in its headquarters and outstations.*

### 2.6.5. Biometrics

One junior biometrician working half time for WARDA and half time for INRAB presently provides the research support in biometrics. His contract with WARDA is for 3 months renewable. As we were told, "it is better than nothing", but we do not feel the solution is adequate nor sustainable.

The biometrician has a crucial role during the process of approval of trial designs. The requests for support seem to be coming more from biologists than from social scientists. The biometrician uses a SAS for Windows version to run analyses but, with such limited support, it would be better if scientists themselves had access to a good general biometrics package, preferably open source or cheap. IRRI Stat is an option that should be explored for simple analyses. "R" software package, with its numerous libraries covering a wide array of topics, would be an excellent choice for scientists willing to invest some time into it though there would be a long learning curve.

Faster computers are needed for the biometrics unit. Appropriate books and subscriptions to biometrics journals are missing. Training of WARDA's staff in specialized topics of biometrics would be useful to partly compensate for the presently limited support in biometrics through an upgrade of WARDA's general level in biometrics. The competences of the present biometrician are not in question, but the Panel feels that WARDA does not possess sufficient scientific capability in biometrics with only one part-time junior scientist with a very short-term contract. *Because good statistical design and analysis is an essential component of research quality, the Panel recommends hiring as soon as possible one full time biometrician preferably with good experience in Genotype x Environment interaction analysis, designs of on-farm trials, and analysis of survey data coming from Participatory Varietal Selection.*

### 2.6.6. GIS unit

The IVC has been hosted by WARDA since its inception and is now in its third phase. The GIS unit was established within IVC in 1995, as the need for GIS analysis had increased. The Unit is within the Regional Coordination Unit (RCU) that manages the secretariat of IVC, based in WARDA. The mission of the Unit is to support WARDA projects, partners, and consortia with GIS and remote sensing analysis, modeling, and development of tools for collecting, analyzing and visualizing spatial information. The unit was active until the crisis of 2002 in Bouaké, but subsequently lacked GIS hardware and dedicated office space, with the remaining local GIS/IT assistant operating from the IER-ICRISAT-CIRAD GIS lab based at Sotuba in Bamako, Mali. The unit was revived in September 2004 and reinforced by a junior Dutch professional officer.

IVC has a website and a database on CD of WAIVIS. This system draws upon the data accumulated during 10 years of inland valley research. In 1998, with the completion of agro-ecological characterization, data of 10 member countries, 15 valley systems (semi-detailed level) and 10 watersheds (detailed level) were stored. The characterization covered agronomy aspects, socio-economics, climatology, geology, geomorphology, soils, hydrology, flora and fauna.

National databases have been developed in Benin, Burkina Faso, Togo, and Guinea, and have been recently started in Mali. National scientists are trained by WARDA GIS staff in the structure and creation of a national database using a new format called NIVISA to facilitate information exchange between participating countries. The unit also offers short-term thematic training on

GIS to some members of NCU – a body that brings together national institutions involved in sustainable development of the inland valleys.

The unit is well equipped in terms of hardware and software to perform RS and GIS analysis. Currently, there is limited usage of this service by WARDA's scientists, most probably due to lack of knowledge in RS/GIS. These tools are extremely useful for the stratification of the biophysical and socio-economic environment for research targeting. Therefore, the Panel suggests that WARDA's scientists, irrespective of discipline, be trained in the use of these tools.

#### **2.6.7. Library services**

The role of the library (previous staff of 6 now down to 5) is to ensure scientific information collection, processing, preservation and dissemination. After the Côte d'Ivoire crisis, the library strategy was to develop electronic support and web connections to documentation suppliers. The library directly subscribes to 86 journal titles, which are available in both print and electronic forms for headquarter as well as out-posted staff. Through collaboration with CGIAR Libraries and Information Services Consortium and Documentation Centers, the library has access to many additional journals, to inter-libraries loans (fast procedure), and to the FAO WAICENT portal for grey literature.

Most of the physical collection of journals and volumes is still in M'bé, where one library staff is still posted. Through the installation of The Essential Electronic Agricultural Library update (Cornell University), users now have access to retrospective journal issues from 1999-2003. Around 70% of the requests received by the library come from WARDA and 30% from the rest of the world. Conversely, anyone can have access to WARDA-produced documents through the CGIAR virtual library site (<http://vlibrary.cgiar.org>), but this does not give access to the content of WARDA's library. The library manages the scientists' list of publications. Therefore, it would make sense for WARDA's management to ask them to also compute the indicators of the Center's productivity in terms of publications. The library budget is said to be reasonable. Overall, the library seems well managed and efficient, but would greatly benefit from improvement of the internet connectivity for literature search.

#### **2.6.8. Publications unit**

WARDA's Publications Unit works actively with WARDA and NARS scientists to assist them in journal article preparation, as well as in publishing documents in various forms from leaflets and posters to conference or workshop proceedings, often in English and French (1 full time English editor and 2 French editors). WARDA is a bilingual institution (French and English), and the most important documents are published in the two languages. The "Ivorian crisis" had delayed a number of printed publications, and created a temporary fall in scientific submissions to journals that has now been corrected (see 3.2.). The presence of high-level in-house editors is an advantage in CGIAR Centers, and is extremely helpful for scientists (and envied by other research institutions). Attention has, however, to be paid to keep a reasonable balance between time devoted to institutional versus scientific publications. The Publication Unit is also in charge of the website. It has been revamped several times. Good work was done in terms of both design and content of the present version.



#### **2.6.9. Overall assessment of the quality of research infrastructure, facilities and services**

Adequate infrastructures, facilities and services are an important element for ensuring high quality research. As for most CGIAR Centers, the general quality of the research support available at WARDA ranges from good to very good. In the Panel's view, the major issues deserving urgent attention are those pertaining to N'diaye farm situation (building, equipment and staff), the phone and internet connectivity with the external world, and the reinforcement of WARDA's biostatistics capabilities. With regard to the Cotonou farm situation (space and staff), clarification on the options available at Cotonou will be possible with the advancement of the WARDA-IITA alignment of corporate services.

### 3. RELEVANCE AND QUALITY OF SCIENCE

#### 3.1. Relevance of science

WARDA's mission and strategy were discussed in Chapter 1. In this chapter, the Panel comments on the priority setting process and the relevance and quality of science, including the importance given to research on upland, lowland and irrigated rice, and the programme balance between applied and strategic research, disciplinary and integrated research, and genetic and non genetic solutions to the research problems addressed by the Center.

##### 3.1.1. Research priority setting

WARDA, as part of the preparation of the Strategic Plan (SP) 2003-2012, set up an internal task force to develop research priorities. Knowledge gap analysis was performed, constraint levels were scored, potential impact indicators were considered and all member countries were consulted through the task force mechanisms (ROCARIZ), as well as WARDA's National Experts Committee (NEC) and Council of Ministers (COM). The NEC had two meetings on this topic. The Board also spent considerable time discussing the draft SP. Basically, the research priorities were based on scientist expert judgments. However, because of the turmoil caused by the "Ivorian crisis", the process of priority setting was not as systematic or rigorous as was done for the previous SP. In contrast, for ECARRN, a network in which WARDA also participates, ASARECA used the ISNAR process of priority setting which is a more elaborate and well established process.

The Panel received a presentation by staff on the issue of research priority setting, explaining the principles and methodology used by WARDA. Both are well in line with the SC recommendations. The process is indicated as being continuous. It outlines the nature of the information needed but concludes, "such information is currently lacking for most constraints". Thus, the **Panel encourages** WARDA to collect the needed information.

The SP 2003-2012 outlines the general principles that are relevant for setting research priorities. The Panel believes it is appropriate to include such criteria as the importance of the research issue, "researchability" of the scientific question or constraint being addressed, the probability of success, its likely potential impact, and WARDA's comparative advantage in undertaking the research. The Panel, however, perceives some level of discrepancy between the acceptance of these general principles and their practical application in the priority setting process at WARDA, in part due to the paucity of information referred to above, but also due to the manner in which available information is used at various stages of this process.

We believe the priority setting process would be improved by separately considering the criteria that can be quantified (e.g. yield losses due to various constraints) and considerations that are more a matter of judgment, such as the assessment of country research capacity or the capacity to solve the problem in a defined period of time. The data Tables provided in the SP 2003-2012 by country and ecosystem, classifying constraints into three categories, were useful in this respect, but a real quantification in term of yield losses would be even more interesting. A methodology to perform a scientific analysis of yield gaps due to pests and diseases in the field has been

designed and applied in Asia.<sup>89</sup> It is certainly costly and complicated since it involves experimental approaches, but it would give tangible support to a research focus on one or, more realistically, an association of constraints. Similar methodologies exist to quantify the other types of constraints.

If this were done, and proper weights were assigned to different criteria included in the priority setting exercise, it might be possible to reduce discrepancies between good intentions and actual practice. An example of such discrepancies is the fact that the overwhelming importance of weeds in the upland and lowland ecosystems was regularly mentioned in the SP, but, until mid-2007, WARDA did not have a senior weed specialist nor was weed competitiveness a target in its molecular genetic projects. Other similar examples can also be given, where it was clear to the Panel that even though an exhaustive list of constraints was presented for each ecosystem, there was insufficient indication of how one constraint was weighted in comparison with another, and how the resultant priorities adequately addressed unmet research needs.

In terms of the relative balance between WARDA's current programs, the SP 2003-2012 set the following program priorities: Program 1: Integrated Rice Production Systems (with 4 projects): 65% of resources; and Program 2: Rice Policy and Development (with 3 projects): 35% of resources. However, the analysis of the actual expenditures of the Programs shows that the trend is actually decreasing, with Program 1 receiving 63%, 57% and 53% of the research resources in 2000, 2003 and 2005 respectively. The justification for this decreased relative priority is not discernable from the available documentation. In the Panel's view, based on its assessment of these Programs in Chapter 3 and the research gaps that still need to be met, this decreasing trend needs to be gradually reduced, so that Program 1 again receives about two-thirds of the total research budget, as envisaged in the Strategic Plan for 2003-2012.

The Panel is concerned also that translating the above priorities into appropriate MTP priorities and projects is complicated by the requirement by the Science Council that a "rolling" MTP be prepared every year. This scatters the information in several documents, and represents an unnecessary administrative burden for the Centers. WARDA, like other CGIAR Centers, has conscientiously prepared such plans; and has discussed them annually at the research program, institute management, and Board/Program Committee levels. Despite these several levels of discussions, the scope and depth of MTP discussions, and hence the actual process of research planning and priority setting has remained rather unsatisfactory. Perhaps this is to be expected from a "rolling" planning process that tends to favour incremental changes over the previous year's MTP, and inclusion of new (usually restricted) projects that can be more easily justified for inclusion, not because they more demonstrably meet the Institute's strategic priorities but because they are more likely to receive external (donor) support. Unfortunately, the problem appears to be systemic in the CGIAR, and the Panel does not have a simple solution for this larger issue; but still believes that there is scope for more systematic priority setting for research undertaken by WARDA.

*In order to improve the priority setting process, the Panel recommends that WARDA collect relevant background information, assign appropriate weights to the constraints identified, focus only on a few major constraints of regional interest for each rice ecosystem, and better define*

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<sup>89</sup> Savary S, Willocquet L, Elazegui FA, Castilla N, Teng PS, Rice pest constraints in tropical Asia: Quantification of yield losses due to rice pests in a range of production situations, Plant Disease, 2000, 84:357-369.

*homogeneous target areas (e.g. through stratification of the biophysical and socio-economic environments).*

### 3.1.2. Importance given to each ecosystem (upland, lowland and irrigated)

The allocation of resources according to rice agro-ecologies in the SP is shown in Table 3.1, below.

Table 3.1 Allocation of WARDA resources, 2003-2012, according to rice agro-ecologies			
Ecology	Area (%)	Production (%)	WARDA's R&D effort (%)
All (cross-ecology)	-	-	20
Rainfed uplands	48	29	30
Rainfed lowlands	30	36	30
Irrigated	11	26	20

Source: WARDA Strategic Plan 2003-2012, Table 2, p. 11.

The resource allocation to different rice agro-ecologies is difficult to judge, because it involves a trade-off: the largest area under rice is in the rainfed uplands where most of the rural poor live, but the lowlands (rainfed and irrigated) are where most of the potential for intensification is. Presently, WARDA is spending equal resources on the rainfed lowlands compared to the uplands. Most of the potential for intensification and production increase is in the rainfed lowland ecosystem through inland valley development and management (SC issue 3), as stated in the CCER on Integrated Genetic and Natural Resource Management. The existence of the IVC devoted to an eco-regional approach for the inland valleys shows to the Panel that WARDA is putting strong and justified emphasis on this ecosystem.

Investments on upland rice research have often been criticized in Asia and in Africa by evaluation Panels (e.g. "upland is not and will not be a major rice production ecology in West Africa in the future" or that "it has no long-term sustainability", sentences extracted from the same CCER 2006<sup>90</sup>). Such criticism has claimed that it is difficult to improve the ecosystem productivity because of the array of constraints, and that the potential for improvement will only be achieved through important changes in the production system. The constraints are undeniably strong but such statements ignore realities. Uplands are still representing a large part of the rice area (48% in Africa) and the largest farming population, and this situation is not evolving towards a reduction of upland rice importance. In Uganda, for example, the whole recent increase in rice production is through area expansion with NERICA 4 in the uplands. The level of upland rice productivity reached in Latin America, notably Brazil, is a good example of the possibility of intensification of upland rice in favorable economic and environmental conditions. NERICAs were designed and bred for the uplands, and, even if the first generation of progenies does not have yet all the requested qualities, hopes for better material are opened by the progress in the exploration of the African gene pools. Thus upland rice should be a research target in itself with adequate funding, and not just be expected to benefit from spillovers of research conducted for the other ecosystems, that would be of limited applicability anyway. Hence, on this aspect, the Panel fully agrees with WARDA's analysis.

<sup>90</sup> CCER on Integrated Genetic and Natural Resource Management, WARDA, Cotonou, 2006.

Resource allocation to the irrigated ecosystems should also be maintained, even if it is already reaching a very high yield, and even if it may have negative environmental effects in terms of methane emission, excess water use or salinity increase that, if improperly managed (SC issue 3).

Tentative estimates show that rice is responsible for about 12% of the world's global methane emissions (IRRI, 2004, <http://www.irri.org/docs/IRRIEnvironmentalAgenda.pdf>), but most of the rainfed and irrigated rice areas are in Asia (2.6% in Africa against 93.8% in Asia). Mitigation options have been formulated by WARDA, involving water and residue management without additional cost for the rice farmers. Competition for water between agricultural and non-agricultural uses is increasing everywhere, including in Africa. The problems of water use and salinity are generally interlinked. Excessive irrigation and water logging lead to the build-up of salinity in the soil, and depletion of groundwater in river deltas can lead to seawater intrusion. Again, solutions exist or can be devised to reduce the impact of these problems. Part of the problem can be handled through local organization and policy (as done by SAED in Senegal, or Office du Niger in Mali), or through appropriate agronomical practices limiting losses such as better land leveling, crack ploughing and bund maintenance. WARDA is focusing on issues solvable by research such as the improvement of rice water use efficiency, or the evaluation of the aerobic rice production system that, besides the decrease in water use, could also help to decrease methane emissions.

The priority given to minimization of environmental impact has to be balanced against the need for an increase in food production. Ultimately, one has to remember that irrigated rice represents 11% of the rice growing area, but 26% of the production in SSA. In a situation of large importation of rice into the region, this fact cannot be ignored.

Based on the above discussion of resource allocation, and recognizing the continuing need for increased rice production and the possibilities of improving rice productivity and supply through research by WARDA—and notwithstanding the limitations of the information available on the subject—it seems to the Panel that WARDA's resource allocation for research on the different rice ecosystems is reasonably balanced (SC issue 3).

### **3.1.3. Programme balance**

In the Panel's view, WARDA has to pay attention to three issues related to programme balance: a) balance between applied research with immediate impact and local application, and more strategic research with medium term benefits and regional application; b) balance between disciplinary and multi-disciplinary (integrated) research; and c) balance among the various disciplines essential for rice research, notably the weight to be given to genetic or non genetic solutions to research problems.

#### **3.1.3.1. Balance between "strategic" and "applied and adaptive" research**

CGIAR Centers are expected to conduct strategic research as well as provide the link between basic and more adaptive ends of the research-development continuum. Accordingly, WARDA activities are devoted to "research for development" (R4D: a term recently popularized within the CGIAR by IITA).

In seeking this balance, WARDA seems to be getting caught between pressures to show immediate impact on rice production (coming from donors and/or governments of Member countries), and pressures (primarily) of the CGIAR SC that does not want WARDA to “replace” weak or under-funded NARS or extension systems that are all too commonplace in SSA. However, we note that the SC recognizes that the appropriate balance is difficult to establish.

WARDA documents indicate that Program 1 devotes about 60% of its resources to strategic research, and 40% to applied and adaptive research (SP 2003-2012). The validity of this ratio is difficult to assess at the institute level; but based on its detailed assessment of the research program (see Chapter 2) the Panel believes that WARDA in fact spends more than 40% of its resources to what could reasonably be considered applied and adaptive research.

In the Panel’s assessment, WARDA appears to be quite efficient in product delivery; but in trying to ensure the dissemination of the technology it has developed, it occasionally seems to go too far towards the development end of the research-development spectrum. There is presently too much focus on applying solutions to problems (i.e. on applied and adaptive research) and too little on developing new concepts and methodologies, and understanding mechanisms and processes (which can better be done through strategic research). Some of WARDA’s activities seem focused on delivery systems and organizations (networks) which—though they are useful and sometimes needed, as discussed in Chapter 4 on partnerships and networks—utilize the products of research but cannot themselves be termed science. When bottlenecks in the impact pathway (such as shortage of seed) are not really scientific issues, the Panel feels it is justified to help design the means to tackle the problem (e.g. ARI) but once the mechanisms have been established, it is necessary to devise a clear exit strategy so that WARDA’s continued involvement in the “downstream” dissemination activities does not use up valuable and scarce research funds.

Besides the examples discussed in the chapter on partnerships, the Panel draws particular attention to the need for balance in genetics and physiology between research on *O. sativa* or *O. glaberrima*, and NERICAs. The Panel notes that the improved performance of NERICA varieties can be due to alleles from *O. sativa*, or from *O. glaberrima* or, in the case of quantitative traits, from an optimal combination of alleles from the two sources. Hence research emphasis on NERICA alone may not yield desirable results in terms of crop improvement (see details in Chapter 2.1.); and in addition (or sometimes instead of) focusing on applied research on NERICAs, there may be much more to be gained from strategic research on *O. sativa* as well as on *O. glaberrima* (for which much less is currently known than for *O. sativa*).

*The Panel recommends that WARDA allocate more time and resources to the development of concepts and methodologies, and to understanding genetic and physiological mechanisms and processes responsible for superior performance in the appropriate genetic backgrounds (O. sativa, O. glaberrima, or NERICA, according to the situation).*

### **3.1.3.2. Need for integration of research**

WARDA has utilized a program and project approach for organizing its research. The project-oriented approach is supposedly more favorable to multidisciplinary research. Though this structure undeniably facilitates exchange of views amongst members of multidisciplinary project teams, the Panel believes that WARDA does not get the best out of this choice of structure, and does not go far enough into truly integrated multidisciplinary research. Some research aspects

that call for integration of various disciplines are notably absent; for instance, understanding GxE interactions in the target areas and developing ways to control them could be a common issue within and between several projects and disciplines. Another striking example is the limited interaction between breeders and social scientists in PVS approaches; the socio-economic surveys done by WARDA could serve better as possible feedback into breeding objectives (as discussed in Chapters 2 and 5).

The Panel recognizes the inherent complexity of projects that require true inter-disciplinarity, particularly the real effort needed by single discipline-oriented scientists to learn from each other and to establish common ground for discussion. This requirement—as well as the difficulty of implementing it—is illustrated by the issue raised by the SC concerning the existence of an independent drought project (SC issue 13). WARDA seems to be reproached for building a “stand-alone” project to please donors and to gain visibility in an under-researched area for addressing issues that could presumably be equally well tackled partly in an upland and partly in a lowland project. In the Panel’s view, however, besides the intrinsic complexity of drought as a research issue, this project clearly needs a marked interdisciplinary approach since it must consider a large set of very diverse variables—from the very large (environment, climate, etc.) to the very narrow (genes and alleles). We believe the choice of a specific stand-alone drought-related project was a good one, to ensure that in this project (at least) all these various aspects could indeed be well integrated. To dismantle or disaggregate this project and put its parts into two separate projects could in fact make it more difficult to undertake interdisciplinary research, and could even lead to a loss of focus on “drought”. In saying this (and in response to SC issue 13), the Panel recognizes also that there is no such a thing as a perfect structure. The best organization is the one that facilitates the work of people really motivated to work together and solve problems, so some freedom should be given to each Center to organize itself and its projects the way it prefers.

### **3.1.3.3. Balance among the various disciplines essential for rice research**

Based on its assessment of WARDA’s research activities (see Chapter 2), the Panel believes that a better balance is needed between breeding and genetics - oriented research activities and agronomy. In Program 1, for example, there are 10.5 staff FTE for breeding/genetics against 6.9 staff FTE in agronomy (see Annex XI) which gives the staff time allocation for each discipline. Genetic improvement activities are the trademark of CGIAR Centers; and it is indeed important to have good genetic potential, but this can only be realized if crop management research is adequate. Nutrient management research has to be conducted on relevant genetic material, and this may contribute to the impression that all relevant research revolves around breeding; but, even considering this bias, our impression is that in WARDA, genetic research activities overshadow other disciplines. WARDA should seek a better balance between seeking breeding solutions and other types of solutions depending on the type of constraints being addressed. For example, WARDA has put less emphasis on crop management options for weed control when it started to work on interspecific hybrids that are supposedly weed competitive (see section 2.2.5. on weed management). Likewise, though the Panel commends the place given to socio-economics, it is concerned about the lack of critical mass in this area of work (see Chapter 2.4), which puts into question the satisfactory delivery of the expected outputs.

## 3.2. Quality of science

### 3.2.1. Processes in place to ensure quality

The quality of science management can be guaranteed through a set of activities involving internal and external assessments of planned and ongoing research activities, and development of a quality assurance (QA) policy to ensure that research products meet the expected standards of quality. Many of these elements are in place at WARDA at the institution and program level (internal and external reviews) as well as at the more basic experimental level.

#### 3.2.1.1. External reviews

One of the mechanisms to ensure research quality is to have regular reviews that could facilitate needed changes in research orientation and quality. At the institution level, this involves the EPMRs, CCERs, and donor commissioned reviews. By choice or by obligation, WARDA is regularly subjected to such evaluations; but these reviews seem to have been of uneven quality. In addition, many reviews have been undertaken during the past six years, giving the impression that WARDA has been over-evaluated during the period covered by this EPMR. The Panel analyzed all the recent reports and concluded that not all of them brought something particularly useful or original to the debate. They were often too close in time, concentrated at the end of the period under review (presumably because of the disruption created by the “Ivorian crisis”), had too broad terms of references, or made contradictory statements; and collectively, represented a heavy burden for both Center Management and scientists.

Donor commissioned project reviews cannot easily be avoided; but efforts should be made to limit the number of narrowly-focused/project reviews. *The Panel suggests that the Board-commissioned CCERs be reoriented and be more forward looking; and be undertaken by experts specialized in the areas relevant to the topics covered by the review so that its results could help WARDA scientists strengthen research quality on a given topic.* Also, to improve the relevance and quality of research undertaken at WARDA, some reviews should focus not on assessment of work already done but should instead provide expert advice on what kinds of research WARDA scientists should undertake in the future. An example of such a review would be to invite a specialist on GxE interactions to help design a workplan aimed at defining target breeding environments and help prepare a project for submission to donors. The same applies to weed or water management, both of which are inadequately covered by research undertaken by WARDA.

#### 3.2.1.2. Internal assessments

At WARDA, internal assessments are undertaken through the following instruments:

- Annual staff evaluations;
- Research Days, held in November, at which every project is subjected to review of the past year's work, and plans for the following year are scrutinized. In this one-week long exercise, NARS and other partners are invited, two members of the Program Committee of the Board attend as observer-participants, and one or two distinguished scientists are occasionally invited to lead a discussion on emerging scientific themes;
- critical discussion during the NEC meetings of the research programs' relevance for Member states of WARDA;
- in-depth review of IRS performance, eight months prior to expiry of contract;



- monitoring tours jointly conducted with NARS and other partners within the various networks; and
- Regional Rice Research Reviews (termed the 4Rs) organized every two years by ROCARIZ task forces. In this forum, external scientists are invited.

Collectively, these internal assessments, in which external inputs are also sometimes sought, cover all organizational levels--individual scientists, projects, networks--and seem to the Panel to be frequent and thorough enough.

### 3.2.1.3. Quality assurance (QA)

Standard Operating Procedures (SOPs), well maintained equipment facilities, quality monitoring and auditing, statistical considerations and documentation, and training in these issues are all expected to be part of a good quality assurance (QA) plan. The Panel is not aware of a formal QA plan at the institute level, but was happy to note that many elements of it were already in place (e.g., SOPs for IT use, biometric control on experimental designs, protocols for PVS trials, etc.). In the Panel's view, WARDA can only benefit from a more systematic and comprehensive collective brainstorming on these issues, organized by the ADG for Research, and this would be expected to help articulate a proper plan for quality assurance in all aspects of research. The Center's quality assurance policy is already a required field in project proposal forms for some donors, and in some other non-CGIAR institutes this requirement is very adequately satisfied by a response indicating that the Center or particular research unit meets international quality certification standards (ISO 9001 norms). In the Panel's view, it is just a matter of time before such certification could be required of all international Centers. *The Panel therefore suggests that WARDA prepare a comprehensive QA Plan for the institute, which could then potentially serve as the first step toward seeking ISO certification for the Center or one or more of its research laboratories.*

### 3.2.2. Critical mass

A small number of scientists working in many different disciplines, as is the case at WARDA, can find it difficult to undertake first class disciplinary research, which (globally) is more and more the result of team effort among collaborating scientists located elsewhere. However, it is difficult to determine what should be the minimum critical mass for an institution such as WARDA whose program is still evolving; and of course, the staffing levels will also depend on funding or collaboration opportunities. Nevertheless, based on our assessment of the research program (see Chapter 2), we believe WARDA is currently an under-staffed institution. This is in part due to the lingering after-effects of the "Ivorian crisis" five years ago, which made it difficult to retain the most experienced people. Now that the program and management of the Institute seem to have stabilized, more efforts should be made to recruit new senior staff of international stature. Another way of dealing with the critical mass issue would be through secondment of scientists from advanced institutions working on areas of common interest.

The argument invoked by WARDA that it uses its partnerships with NARS to leverage resources and to augment its "critical mass" is valid, but only in relation to applied research. NARS have their own specific objectives that may not always fit with WARDA's. In addition, the Panel is concerned about transaction costs for such strategy: time lost in travel, time dedicated to specific needs of each individual partner, difficulties of communications etc. WARDA's scientists cannot just act as coordinators of a network of NARS scientists. They have to have their own research

programs on strategic issues if they wish to maintain a good scientific program with high credibility. Having many different partners in many different countries is already taking a very large toll on the personal research activities of key scientists (e.g. some breeders) whose contributions are expected in a wide range of projects. This could have serious consequences on research quality; and the situation can only worsen with the planned expansion of WARDA's membership as an association, unless additional staff are recruited to continually match "critical mass" with critical needs.

The same word of caution applies to WARDA's continuing evolution towards the development end of the research-to-development continuum. A major risk for scientists is dissipation of energies on areas of research in which they have little comparative advantage. Instead of asking WARDA scientists to engage in development-related work, such activities, which have to have a strong local component, should be left to other organizations more suited to this task (NARS, extension agencies, NGOs, etc.).

*In order to ensure that available scientific talent is utilized primarily for science, and in order not to compromise research quality, the Panel recommends that WARDA make every effort to achieve a reasonable balance between in-house scientific activities and external network or partnership activities that focus more on development than on research.*

As important as the number and quality of senior scientists is the research support available to them. The Panel worries about the reduction in the number of well-trained and qualified research assistants—fewer of whom are currently engaged in research at the Cotonou site, compared with the much larger numbers that were available in M'bé, prior to the "Ivorian crisis". The Panel was told that in some projects daily workers are currently being used for making field measurements and that the Farm Unit too was using under-trained workers for undertaking specialized operations. While additional training could compensate for lack of experience, in the Panel's view frequent turnover of such especially trained staff can be detrimental to research quality. In addition, there is potential loss of efficiency, for there can be considerable loss of time in having too frequently train new batches of research technicians and field staff. The Panel therefore urges WARDA management to find ways to ensure a high-quality stable work force in the research support functions, while of course keeping in mind the requirements of local labor laws in Benin and other countries where WARDA scientists conduct research.

### **3.2.3. Indicators of science quality**

#### **3.2.3.1. Publications**

Scientific production is a good proxy of the quality of science. For this reason, following the SC standard methodology, the Panel analyzed the scientific production of WARDA's IRS research staff present at the time of the review over the last five years and compared this snapshot of WARDA's results with CGIAR averages. Out of the 44 IRS (including post-docs and regionally recruited staff) reported by WARDA in 2006, 29 (66%) indicated they devoted at least 25% of their time to research activities. The remaining 34% were IRS devoted almost solely to management activities, and were therefore not considered IRS researchers (IRS-R).

Over the 2000-2005 period, these IRS-R published over 400 publications (books, book chapters, communication to conferences or congresses, and journal articles), which means over 95

publications annually. Details per discipline are presented in Table 3.2 (see the full list in the Annex XII). Approximately 33% were peer-reviewed. WARDA's scientists publish slightly less peer-reviewed publications than the CGIAR average (see Table 3.3). Only 2/3 of the IRS-R published peer reviewed journal articles, which seems surprisingly low, notably when compared with the CGIAR average. The Panel suggests that the causes of this should be analyzed and the situation monitored by WARDA. Considering only the publishing scientists, the number of peer-reviewed articles per IRS-R, per year is also below the CGIAR average. However, given the two successive relocations, the abrupt departure of very experienced scientists after the "Ivorian crisis", and the loss of the long-term trials in M'bé, the Panel is of the opinion that it can be considered as satisfactory.

<b>Table 3.2 Number of Publications (*) of WARDA scientists (**) by Year and Research Area</b>										
	2000	2001	2002	2003	2004	2005	2006	<i>Ove- rall</i>	Average ***	
Breeding and Molecular sciences (Breeding, Biotech. and Genetic Resources)	6 (4)	9 (4)	7 (4)	8 (3)	28 (6)	20 (5)	20 (5)	98 (31)	3.2	
NRM / Agronomy	17 (3)	24 (5)	7 (5)	11 (3)	4 (5)	18 (5)	24 (4)	105 (30)	3.5	
IPM	13 (6)	10 (3)	8 (2)	7 (2)	11 (2)	14 (2)	7 (2)	70 (19)	3.7	
Partnerships/Networks/TT/ Innovation systems	3 (4)	16 (9)	11 (8)	7 (11)	1 (11)	25 (11)	13 (12)	76 (66)	1.2	
Socio-Economics	4 (3)	7 (4)	7 (4)	7 (3)	5 (4)	2 (4)	9 (6)	41 (28)	1.5	
Institution/Systemwide	3 (1)	6 (3)	0 (3)	1 (4)	0 (4)	5 (4)	3 (7)	18 (26)	0.7	
<i>Overall</i>	46 (21)	72 (28)	40 (26)	41 (26)	49 (32)	84 (31)	76 (36)	408 (200)	2.0	

\* Journal articles, books, book chapters and edited proceedings (including publications with NARS, according to the PM Indicators). (\*\*) in brackets: the number of internationally recruited scientists that took part in the research programs in each year. (\*\*\*)Average refers to publications per person per year for the entire period.

To assess the quality of the journal articles, the Panel, although conscious of the limits of such indices<sup>91</sup>, used journal impact factors and ranks in the discipline. The data submitted to us showed that 243 articles were published in journals between 2000 and 2006. Roughly, 58% of the papers were published in journals with impact factor (average of 20 per year, higher than the 16 recorded for the 1994-1999 period), against 42% in national or local journals without impact factors. The impact factor mode is at 1.0 and only 13.5% of the publications have an impact factor of more than 2.0. The rank of the journal in the discipline (Agriculture in most cases) is more satisfactory with 71% of the publications in journals ranking above the average of the discipline and 16% ranking in the 10% best journals of the discipline. Based on these criteria, the number of published papers per scientist appears moderate and, with the exception of a few excellent papers, the impact levels are good for the domain but not exceptional. This reflects the

<sup>91</sup> Amin M. and Mabe M., Impact factors: use and abuse. Perspectives in Publishing, 2000, 1:1-6.

orientation of WARDA that, in the research-to-development continuum, tends to put the cursor closer to development activities that international journals judge too site-specific for a large audience.

<b>Table 3.3 Scientists' productivity for the previous five years for the IRS-R that were present in 2006: WARDA and the CGIAR (*)</b>		
<b>Productivity indicator</b>	<b>WARDA</b>	<b>CGIAR Average</b>
1. % of IRS-R that publish peer reviewed publications (books, conference proceedings and/or journal articles) (29 scientists)	86	81
2. % of IRS-R that publish peer reviewed journal articles (29 scientists)	66	83
3. Number of peer reviewed publications (books, conference proceedings and/or journal articles) per IRS-R per year (29 scientists)	1.1	1.7
4. Number of peer reviewed journal articles per IRS-R per year (29 scientists)	0.7	1.2
5. Number of peer reviewed journal articles per publishing IRS-R (19 scientists) per year	1.0	1.4
6. % of IRS-R that have received honours and prizes (29 scientists)	41	24
7. % of IRS-R that have supervised degree students (29 scientists)	55	56
8. average # of students supervised (29 scientists)	5.0	5.2

(\*) Considers only internationally recruited staff devoted to research (IRS-R)

Source: SC, based on information provided by WARDA.

Based on this analysis, *the Panel encourages scientists to publish better rather than more*: articles rather than conference proceedings, even peer-reviewed; in international journals rather than in local ones; and in English rather than in French. In the DG's New Vision, WARDA's scientists are expected to publish at least two peer reviewed journal articles per year. The Panel recognizes that this takes considerable time, and, to a certain extent, imposes to adapt research for publication. Notwithstanding the difficulties, the Panel encourages scientists to invest more into this activity which is absolutely essential for their individual career and, globally, for the scientific reputation of the institution.

### **3.2.3.2. Officially released varieties**

The institutional output in terms of publications is one way to evaluate science quality but other measures of quality are also important, notably patents. For institutions strongly involved in plant breeding, officially released varieties should be considered as equivalent to patents. Table 3.4 summarizes the varieties released in West Africa during the 2000-2006 period.

Table 3.4 Varieties adopted and/or released during the 2000-2006 period		
Rice ecology	Number of varieties adopted or released	
	NERICA	Other
Upland	18	1
Lowland	11	-
Irrigated	3	17
Others	-	-

Source: WARDA

WARDA itself does not propose varieties for release. It is NARS a role. Many "adopted" (when there is no formal release system in the country) or released varieties, however, result from regional collaboration between NARS and WARDA. It is impossible to determine precisely what respective parts NARS and WARDA played in this process, but this part is obviously very important since the NERICAs, for which WARDA played the major role in the hybridization and selection processes, represent a very large part of the released varieties. For the irrigated ecosystem, the non-NERICA varieties are either coming from WARDA *O. sativa* program (Sahel varieties) or are introductions often through INGER-Africa. WARDA's achievements in this domain are indisputable. Moreover, the figures can be considered as conservative estimates. In the past, monitoring tours organized by INGER-Africa allowed to collect information on the released varieties in the member countries participating in the network. Monitoring tours have been discontinued. Efforts are being made by WARDA to continue to collect the same information but only a couple of countries answered the most recent survey.

From the background of the released varieties, the Panel wants to draw attention to the fact that WARDA seems to be the almost exclusive provider of new varieties in Africa. This shows a worrying weakness of NARS breeding programs. The Panel was struck by the fact that ISRA in Senegal, for example, did not feel it necessary to have an irrigated rice breeder. We understand the pragmatism of ISRA but feel it is a heavy responsibility for WARDA.

### 3.2.3.3. Place in the international research effort

Another way to measure research quality is through the role played by WARDA scientists in the coordination of international efforts on African rice, and the rate of approval of competitive research proposals they developed. WARDA scientists are regularly associated to successful commissioned or competitive scientific projects; and the Panel, well conscious of how much time and effort this represents, congratulates scientists for the number and the quality of the projects they are involved in. This success is absolutely essential for the financial health of the Center.

### 3.2.3.4. Awards, honours and prizes

During the review period, several important awards were won by individual scientists or by the institution itself. Most of these were related to the development of interspecific *sativa* x *glaberrima* hybrids, notably the prestigious World Food Price for Dr Monty Jones and the Koshihikari International Price from Japan to Dr Moussa Sié. Other awards were won for the ASI thresher-cleaner and for excellence in communications. As shown in Table 3.3 the percentage of IRS-R who have received honours and prizes in the last five years is nearly twice the CGIAR average. These awards are prestigious and well deserved, and acknowledge WARDA's strong

contribution to African rice research and development, notably its successes in exploiting the African rice gene pools.

#### **3.2.4. Global public awareness versus scientific communication**

In the modern world, research, as all other types of activities, has to justify its role and demonstrate its effectiveness. For institutions that rely only on donor funds to survive, the temptation is strong to oversell potential products and breakthroughs to donors. Breakthroughs are by definition one-time shots and it is difficult to maintain the level of interest of donors over a long period. Overselling research activities have immediate benefits in terms of donors' support that reward success stories, but it has a long term cost, which can be the loss of trust of the scientific community if research results do not back up the initial claims.

Other CGIAR Centers seem, in retrospect, to have succumbed to this temptation, perhaps inadvertently. The Panel thinks that WARDA too needs to be cautious with the NERICA story and the way it is sometimes reported, probably by excess enthusiasm. The fact that interspecific hybridization between *O. sativa* and *O. glaberrima* is now possible for any kind of parental combination is a *true scientific breakthrough* and opens broad perspectives for rice genetic improvement. However, it would be a stretch to say it "revolutionized the approach to rice breeding" since examples of successful interspecific hybridization within the *Oryza* genus are old (e.g. introgression of *Xa21*, a gene of resistance to bacterial blight from *O. longistaminata* into Asian varieties in the 70s). The 150.000 ha or so grown with NERICA in SSA (6.7% of the upland rice area) is evidence of success in dissemination but it is not yet a "Green Revolution in Rice in SSA", although it may be a step towards it. The temptation to present NERICAs as a solution to all African rice problems risks undermining truly good scientific work and real impact. The Panel understands how the NERICA story can boost rice production in Africa, and therefore rice research, and the need for it, but the Panel also feels that WARDA should pay more attention to the balance to be maintained between scientific communication and public promotion and awareness building. Depending on the audience, the message has to be adapted. For a scientific audience, it has to be backed up by solid facts. For a broad audience, the message should not be overoptimistic or raise unrealistic expectations.

#### **3.2.5. Concluding remarks in Relevance and Quality**

It is the Panel's view that WARDA has conducted very relevant work focusing both on genetic and non-genetic solutions to rice production systems in Africa. The achievements are many, and are in line with its mission and CGIAR systems priorities. These are dealt with in detail in Chapter 2.

WARDA has placed considerable effort on the elaboration of its SP 2003-2012. This is a positive development as it gives a framework from which MTP plans can be developed. However, the relevance and the quality of science at WARDA could greatly be improved if the current research priority setting process were improved.

There is a need for better targeting of research activities, and the Panel (Section 2.2.6) suggests a methodology for stratification. These would enable the Center to focus only on a few constraints of regional importance. Then, appropriate crop improvement and NRM management solutions could be specifically developed and disseminated to the target areas, ensuring better adoption by

the farming communities. The proposed research planning could also facilitate better interdisciplinary at WARDA.

The allocation of resources should gradually favour the technology generation project activities (Program 1, currently 53%) in relation to support activities (Program 2). Resource allocation between the major rice ecologies is satisfactory, and responds to the need for intensification of the irrigated and rainfed lowlands. In relation to research-development balance, it is suggested that the Center places more emphasis on strategic rather than applied research, and identify and strengthen strategic partners for product delivery. Moreover, a better balance between breeding and NRM research activities should be ensured and WARDA's role be better demarcated from that of NARS based on their respective missions and comparative advantages.

Very good progress has been made in the implementation of measures to ensure quality of science. Nevertheless, more can be achieved with forward looking and more specialized reviews in areas of strategic importance. The Panel believes that good progress has also been made in terms of the development of rice varieties. The publication record of WARDA is good in number and in quality, though the number of papers per scientist is below average compared to other CGIAR Centers. Finally, WARDA is understaffed in some areas of research. Steps need to be taken to improve critical mass, and to use researchers primarily for scientific rather than networking activities.

## 4. PARTNERSHIPS AND LINKAGES

WARDA's *modus operandi* is partnership at all levels. WARDA has developed highly diversified partnerships with all levels of the rice sector. All stakeholders in the countries visited commended WARDA's partnership mechanisms. Indeed, WARDA is recognized as a "partnership Center" with privileged relations with its constituency, mainly constituted by NARS. This is very important for the development and uptake of its technologies in the countries. The previous EPMR recommended a periodic review of WARDA's partnerships. The Panel benefited from a CCER on partnerships done in 2004. This was the first CCER on partnerships by WARDA and in the CGIAR system. The CCER team traveled extensively in seven WCA countries. However, this CCER also dealt with many other issues at WARDA, including research priorities and balance, research methodologies, outreach activities, variety release, registration and seed distribution, publications, etc. That review made 18 recommendations. The CCER's review panel commended WARDA for its partnership model, which it considered unique and exemplary, and which, it said, could be emulated by other Centers. This success was due largely to its "Task Forces" initiative, which was merged with the CORAF/WE CARD rice network to form ROCARIZ.

### 4.1. Links with NARS and networking, including extension to ESA

The partnerships at WARDA operate mainly through networks, as vehicles to ensure relevant outputs (IPG) and to strengthen the overall innovation system. The main networks that WARDA coordinates are ROCARIZ, ECARRN, INGER, ARI, IVC and SWIHA.

#### 4.1.1. ROCARIZ

ROCARIZ was formed in 2000 by merging WARDA's regional task forces with the CORAF/WE CARD's rice network. This was already in progress during the fourth EPMR, and represents a saving in terms of reduced duplication of effort and increased efficiency and effectiveness. ROCARIZ has more than 150 rice scientists in WCA in 21 WARDA/CORAF countries. In the period 1996-2005, about US\$ 2.2 million was disbursed as small competitive grants to researchers of ROCARIZ. Every two years, Regional Rice Research Reviews (4 Rs) are held (in 2002, 2004, 2006). At the 4 Rs, awards are given for best presentation by NARS scientists, best write-up by NARS scientists, and best contribution to rice R & D. In ROCARIZ, there is insistence on increased scientific rigor: the proceedings are since 2004 peer-reviewed, and the best articles are since 2006 published in the African Crop Science Journal.

There is also increased collaboration with universities, with only one university scientist participating in 2002, and seven in 2006. The University of Abomey-Calavi in Cotonou and the University of Lomé in Togo benefit particularly from this inclusion. WARDA operates a visiting scientist's scheme, including from universities, since 1985. The CCER on partnerships recommended enhanced partnerships between universities and WARDA.

This CCER had the following comments on strengths and weaknesses of ROCARIZ: "ROCARIZ's strengths include: excellent Task Force approach (which has increased team work between NARS scientists and among the NARS), assured access to WARDA's expertise, funding opportunities for the NARS, devolvement to NARS of responsibilities for implementing activities, improved NARS interests in writing for publications, a good monitoring mechanism, successful involvement of extension agents, and responsiveness to NARS needs. Its weaknesses



include: domination of network projects by a few active NARS, poor involvement of CSOs at systems level (ARI should collaborate with ROCARIZ to alleviate this weakness), national level partnerships are ad hoc and without clear terms of reference, poor working relationships between Task Forces, and inadequate quantity and quality of publications".

The EPMR Panel relies on this CCER assessment, and notes that recommendations were made to alleviate the weaknesses, but several of these remain, as they are hard to overcome.

ROCARIZ has, for the past five years, contributed significantly to closer and increased research collaboration between WARDA and NARS scientists and among the NARS. In addition, capacity building in the form of devolvement of responsibilities of research activities to NARS and increased capacity of NARS to generate project proposals and scientific publications are other contributions made by WARDA through ROCARIZ. The quality of publications from the NARS and the interactions between various Task Forces within ROCARIZ are yet to improve. During the period under review, publications co-authored with NARS scientists increased considerably from 2000 to 2005. The number of joint project proposals with NARS has also increased during the same period. Through ROCARIZ, WARDA is increasing its scientific capacity and attaining critical mass in areas where alone it would not be possible, as shown in Table 4.1 below.

<b>Table 4.1 Critical Mass through ROCARIZ Task Forces</b>									
<b>Total number of scientists mobilized</b>		<b>Number of projects funded</b>					<b>Participation at 4Rs meetings</b>		
<b>Task Forces</b>	<b>2006</b>	<b>2001-2002</b>	<b>2002-2003</b>	<b>2004</b>	<b>2005</b>	<b>Total 2001-2005<sup>1</sup></b>	<b>2002</b>	<b>2004</b>	<b>2006</b>
<b>Breeding</b>	44	26	22	11	13	72	36	12	11
<b>IPM</b>	40	30	33	14	15	92	40	13	16
<b>NRM</b>	22	17	26	-	8	51	16	14	16
<b>Economics</b>	22	5	8	5	3	21	9	7	12
<b>Technology transfer<sup>2</sup></b>	10	-	6	11	3	20	26	8	5
<b>Total</b>	128	78	95	41	42	256	126	54	57

1 No funding available in 2006

2 Technology transfer started in 2002

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

ROCARIZ supports research on mangrove-swamp rice technologies at Rokupr Research Station in Sierra Leone, as WARDA itself is not doing the research anymore on rice for that agro-ecology.

A milestone in ROCARIZ achievements, together with ECARRN, was the organization of the first African Rice Congress in Dar-es-Salaam, 31 July-4 August 2006. The presentations held at the Congress were mainly from NARS, members of ROCARIZ or ECARRN and there was a sizeable involvement of researchers from Asia, including from IRRI, and from Advanced Research Institutes. The papers presented at the Congress are on WARDA's website. The intention is to repeat the Congress every three years. The Panel commends WARDA for its role in organizing this congress.

#### 4.1.2. ECARRN

The Eastern and Central Africa Rice Research Network (ECARRN) was created by the Association for Strengthening Agricultural Research in Eastern & Central Africa (ASARECA) and is modeled after ROCARIZ, which operates in WCA through CORAF/WE CARD. The main motivation for creating ECARRN is the rapidly increasing rice consumption in cities in ECA, lagging rice production with imports surpassing over a million tons and the great potential for an accelerated uptake of WARDA's products and ultimately impact.

It is to be noted that WARDA's COM made a resolution (#7) at its last meeting in 2005 in Ouagadougou to encourage the expansion of WARDA's geographical mandate in accordance with WARDA's constitution. Two additional arguments explain the establishment of ECARRN. The Canada Fund for Africa made a grant to selected CGIAR Centers, including WARDA, to conduct work outside their normal prescribed mandate (West Africa in the case of WARDA). In addition, it enabled WARDA to access EU funding for rice research only available under ASARECA member countries.

ECARRN became functional in January 2005. ECARRN aims at increasing the efficiency of rice research in the ECA sub-region, to facilitate economic growth, food security and export competitiveness through productive and sustainable rice production systems. ECARRN is one of the seventeen research networks, programs and projects of ASARECA. A priority setting for ECARRN took place in 2003, and a priority-setting workshop by different stakeholders was held. The procedure followed for priority setting was that developed by ISNAR. The result of this priority setting for ECARRN was published by ASARECA in December 2005.

The fourth EPMR suggested that WARDA takes caution and informed judgment into building partnerships in ECSA. Particularly for ESA, IRRI is a natural CGIAR partner as IRRI has already shown interest in this part of Africa. JICA, SG 2000 and other NGOs and the private sector complement WARDA's efforts in this region through ARI. JICA experts are posted in Kenya and Uganda<sup>92</sup>.

WARDA hosts the ECARRN coordinator, a visiting scientist and three support staff at the IITA substation in Dar-es-Salaam. There is also a visiting scientist there. In 2005, a Memorandum of Understanding was signed with NARO of Uganda, and SG 2000. NERICA varieties are now rapidly expanding in Uganda, with 25,000-35,000 ha already being grown<sup>93</sup>.

The Panel believes that WARDA is not over committing resources in this modest expansion, which follows WARDA's partnership and networking mode of collaboration and which is fully demand driven. In addition, ASARECA is pleased with the collaboration with WARDA and points out that the ECARRN network operates according to ASARECA's *modus operandi*.

However, ASARECA is being restructured, WARDA will need to take over ECARRN at the end of its existence as an ASARECA network, planned for September 2007. When the network comes

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<sup>92</sup> The R.D. Congo, Gabon and the Central African Republic have made a formal request to COM to join the Association. Congo (Brazzaville), Ethiopia, Tanzania and Uganda are also expected to make a request.

<sup>93</sup> See also: Kijimo, Yoko, Dick Sserunkuuma and Keijiro Otsuka, "How Revolutionary is the "NERICA Revolution?" Evidence from Uganda, *The Developing Economies*, XLIV-2, June 2006, 252-67.

under WARDA's sole leadership, the challenge will be very great because the expectations are now very high and the countries are many.

In light of requests from Central and Eastern African countries to join the Association, and the COM resolution regarding the expansion of its geographical mandate, *the Panel recommends that WARDA develop a medium and long-term strategy for a phased expansion in Central, East and southern Africa, in line with available funds, without compromising critical mass in West Africa. Moreover, the programmatic alignment of WARDA with IRRI in East and southern Africa should specify their respective roles based on their respective comparative advantages.*

*On the SC issue on whether WARDA has the critical mass to extend reach of activities into ESA, and on what will be the opportunity cost to research for the WCA region,* WARDA has been cautious in expanding into ESA, as outlined above. Because of this modest expansion, no research activities were closed or diminished for the WCA region as the main objective of the expansion is to enable ESA benefit from the research and technologies already developed at WARDA.

#### **4.1.3. INGER-Africa**

This has already been discussed under 2.1.3.5. – rice genetic improvement

#### **4.1.4. ARI (African Rice Initiative)**

ARI was the outcome of the heads of state meeting held in Yamoussoukro (Côte d'Ivoire) in March 2002 (preceded by a COM at M'bé) to alleviate the "quality seed crisis" with respect to the diffusion of NERICAs. WARDA hosts the ARI coordinator and an assistant, has the secretariat (supported by Rockefeller Foundation, USAID, UNDP, Japan), and convenes ARI meetings but operates mainly through the member countries. JICA of Japan seconded a breeder, seed specialist and agronomist to ARI and there is also a U.N. volunteer. ARI covers all of SSA and maintains a presence in each participating country through a stakeholder platform.

ARI is a broker between research institutions and extension services and is now the primary vehicle of dissemination of WARDA products, including new NERICA lines, fertilizer rates, weeding regimes, sowing depth and date of sowing, NERICA based recipes. ARI really took off in 2005 with an AfDB loan of US\$ 38 million to 7 pilot countries in WA. 2,800 tons of seed are now being produced in these countries through ARI. Presently, 100 tons of NERICA 1 & 2 foundation seed are being produced at M'bé, Côte d'Ivoire on the request of the Nigerian government. Special attention was given to the post-conflict countries to help them in their rice sector rehabilitation efforts. ARI is strongly linking up with NGOs (e.g. Songhai in Benin), with links to the private sector being more recently explored.

Since its inception in 2002, the following main achievements have been recorded: the Coordination Unit of ARI, which the Panel commends, constantly addresses seed availability. Table 4.2 provides a summary of foundation seed produced and distributed to several countries through ARI.

<b>Table 4.2 Production and distribution of NERICA Foundation Seed by ARI Coordination Unit</b>							
Year	Seed produced (kg)			Seed distributed (kg)			Beneficiary countries
	B.S. <sup>1</sup>	F.S. <sup>1</sup>	Total	B.S.	F.S.	Total	
2003	75	350	425	65	350	415	Mali, Togo
2004	151	1,063	1,214	100	1,000	1,100	B. F., Mali, Togo, Nigeria
2005/2006	1,474	14,102	15,576	1,400	13,900	15,300	Benin, Burkina Faso, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea, Nigeria, Mozambique, Philippines, Sierra Leone, Tanzania, Togo, Uganda
<b>Cumulative total</b>	1,700	15,515	17,215	1,565	15,250	16,815	

<sup>1</sup> B.S: Breeder Seed, F.S: Foundation Seed

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

In order to increase adoption rate and boost production, ARI facilitated the introduction of more than 400 NERICA lines to farmers through PVS. By the end of 2005, 11 new NERICAs were named, from which three have been released. The newly named materials are mainly extra-early (e.g. NERICA 8, 9, etc.).

ARI activities were initially restricted to pilot countries, but have been extended progressively to more countries. By 2005, NERICA lines had been tested in nearly all SSA countries. Thirteen NERICA lines have been adopted/released in 13 countries (Table 4.3), the number of varieties per country ranging from one to seven.

**Table 4.3 NERICA upland lines adopted/released in selected countries**

Country	NERICA																		Total
	1	2	3	4	5	6	7	8	10	11	12	13	14	15	17	18			
Benin	x	x															2		
Burkina Faso											x	x		x	x	x	5		
Congo									x								1		
DR Congo				x		x	x										3		
Côte d'Ivoire	x	x	x	x	x												5		
Ethiopia	x			x		x											3		
Gambia	x	x	x	x	x	x	x										7		
Ghana	x																1		
Guinea	x	x	x	x	x	x	x										7		
Kenya										x							1		
Mali				x				x					x				3		
Nigeria	x	x	x														3		
Sierra Leone	x	x	x	x	x	x											6		
Togo	x		x	x													3		
Uganda				x													1		
Total	9	6	6	9	4	5	3	1	1	1	1	1	1	1	1	1	1		

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

The CCER on partnerships had the following assessment of ARI: “ARI's strengths are that: it covers the whole of SSA, has a presence in each member country through a stakeholder platform, has facilitated closer collaboration between extension and research in NARES, employs and reinforces PVS-R&E and CBSS, and goes beyond production and development to processing and marketing (adding value). The only weakness identified by partners is that ARI focuses only on NERICAs, thus limiting its domain to the upland rice ecology.”

In the meantime, WARDA has developed 60 lowland NERICA varieties and focuses on the lowlands (including the inland valleys) because of their great potential for production intensification. Five lowland NERICA varieties have now been released and are expected to be promoted by ARI.

The SC states that availability of good quality seed is a bottleneck in taking the fruits of WARDA's research to farmers. How effectively is WARDA collaborating with NGOs, farmer organizations and the private sector to promote the development of 'seed systems' designed to enhance the delivery of promising NERICA lines? The issue of seed quality and availability has been a subject of major focus at WARDA during the past five years, and the issue remains. A second workshop on PVS and PPB was held at WARDA in November 2006 and critically reviewed these issues through a special working group. Recommendations on how to address seed quality were made. In addition, WARDA's 2003-2012 SP outlined the creation of a private seed company (WARDA, Inc)<sup>94</sup>. In general, the private sector for rice is not strongly developed in West Africa; a private entrepreneur from Benin has begun collaborative initiatives with WARDA to start creating farmer seed enterprises.

Seed availability is an issue. Strong efforts are being made by WARDA to remove this bottleneck to varietal diffusion, notably through ARI. As long as seed production does not deprive research of its limited critical mass and resources, it is commendable. The Panel would like to stress that the constraint, which does certainly apply to NERICAs, is also affecting the *sativa* advanced lines and that the benefits of large scale seed multiplication should not be reserved to NERICAs only. The full title of the ARI network implies that other varieties can be included but the tables shown to the Panel only presented NERICAs and no mention was made of the respective shares of the two types of material.

While seed systems are weak in West Africa, *the Panel believes that a long-term solution should involve the development of seed systems whereby the private sector is a partner. Therefore, WARDA should undertake within ARI some activities aimed at strengthening of existing institutions in the seed sector and promoting the establishment of new ones.*

*The Panel welcomes the ARI initiative; but it is too early to make an informed judgment on the efficiency and effectiveness of the initiative. WARDA should be cautious in defining its future role in ARI, which should emphasize training and capacity building on seed systems.*

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<sup>94</sup> The setting up of WARDA, Inc. was discussed during the BOT meeting of March 2007 and no further action is taken at this time.

#### 4.1.5. IVC

The Inland Valley Consortium (IVC) has been hosted by WARDA since its inception in 1993. The IVC is comprised of 12 countries in West Africa. It operates through partners (national coordination units in member countries) and a coordinating unit managed by a Regional coordinator housed in WARDA. Phase I of IVC ended in 1999, whilst phase II ended in 2004. Phase III is ongoing. A Consortium Steering Committee (CSC), reporting to WARDA, meets annually. Its role is to propose directions for scientific strategy and partnership; follow-up and evaluate the overall functioning of the Consortium; amend and adopt the proposed budget of RCU; and evaluate and then select the projects for funding by the Consortium.

The main IVC goal is to foster the production potential of the inland valleys in SSA through the adoption of sustainable technologies and in doing so to improve the livelihood of the rural communities. More information and assessment on soil and water management research conducted in the framework of IVC are in the chapter on rice agronomy and NRM (2.3.1.1 – rainfed uplands and lowlands).

IVC is recognized as the regional NRM platform and has stimulated the financing of large inland valley development projects in Ghana (by AfDB) and in Togo (by UNDP). IVC benefited from long-term funding from The Netherlands (DGIS: 1993-2006), now stopped and being renegotiated. Funding for 2007 is ensured from the World Bank and new funding opportunities are being explored.

WARDA funded projects in IVC are:

- Inland Valley Information Systems (WAIVIS and NIVISA);
- Weed competitiveness of lowland NERICAs in inland valleys (confirming NERICAs superior performance); and
- Curriculum development of PLAR (technical manual);

Externally donor funded projects in the framework of IVC are:

- Sustainable Productivity Increase of Rice in Inland Valleys of West Africa (SPIRIVWA);
- Lowland Development Trajectories Project;
- Community-based Fish Culture in Irrigated Systems and Seasonal Floodplains (with IFPRI and WorldFish); and
- Promoting Ant-based Pest Control in Tree Crops in West Africa (to reduce pesticide runoff in inland valleys).

A CCER was conducted in 2004 on Phase 2 to gauge the usefulness and contribution of this systemwide program (since 1993). The following constitutes the major highlights of the IVC during the review period: The Systemwide program of IVC released WAIVIS (West African Inland Valley Information System) for the first time, available on CD-ROM and via the Web. This software draws upon the data and knowledge accumulated during 10 years of inland valley research. Apart from scientists in national programs, international organizations like IWMI and FAO are using WAIVIS. This led to joint project proposals. WAIVIS has been fully adopted by the NARI of The Gambia to store its data for inland valley characterization. National databases have been developed in Benin, Burkina Faso, Togo, and Guinea, and have recently started in Mali. National scientists are trained by WARDA GIS staff in the structure and creation of a national database based on a new format called National Inland Valley Information Systems of

Africa (NIVISA). NIVISA is a relational database, which permits analyses between countries. Nigeria and The Gambia have indicated that they are discussing similar requests.

FAO, IITA, IWMI, ILRI, IFPRI, WorldFish, CIRAD, and AVRDC have joined the consortium as have three universities (ITC, WUR, Bonn). Twenty-five NARES, 21 universities, 17 government institutes, 9 NGOs, 5 farmer organizations, 4 private sector operators and 2 SROs are the regional stakeholders. The recommendations of the CCER were mainly addressed to the Regional Coordinating Unit (RCU), to WARDA, on financial matters and on the research activities of the consortium. Nearly all of the recommendations were implemented and the CCER is a good example of stocktaking and evaluation before embarking on a next Phase. It was regretted that CORAF/WECARD did not participate during Phase II; they now joined Phase III. In addition, constraints related to water management received too little attention in IVC and are crucial to IVC development<sup>95</sup>. This is still the case now although WARDA intends to recruit expertise in water management.

The IVC is a flagship SWEP coordinated by WARDA with many partners in WCA and in the North that provides the NRM research so vital to the lowland agro-ecology development, which has great rice intensification potential, and for which adapted NERICA varieties are now available. The Panel assesses IVC as a crucial SWEP in WARDA's research program, particularly for NRM in the lowlands. There have been some recent financing problems in IVC and the Panel hopes that these will be resolved satisfactorily. Section 6.9.8 deals further with the financial problems encountered by IVC.

#### **4.1.6. SWIHA**

HIV/AIDS affects the context of CGIAR Centers' work and the Centers cannot ignore the pandemic if they want to reach their goals. SWIHA is the CGIAR Systemwide Initiative on HIV/AIDS and Agriculture. It is organized by the CDC as decided at ICW 2000. The goal of SWIHA is to safeguard and enhance human and agro-ecosystem capacity to produce food, goods and services and sustain livelihoods in the face of HIV/AIDS. The purpose is to mitigate and prevent the negative impact of HIV/AIDS on food security network resources management, poverty and human suffering. Infections continue growing and 63% of people living with HIV/AIDS are in SSA (UNAIDS, 2006). WARDA hosts the secretariat and a coordinator and serves as the convening Center.

SWIHA research produces the following IPGs:

- innovation/knowledge about the linkages between HIV/AIDS and agriculture;
- training manual and modules to be used by health and development workers;
- strategies for improving health and for mainstreaming HIV/AIDS in agriculture and rural development;
- HIV/AIDS communication strategies; and
- policy recommendations/documents.

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<sup>95</sup> The following publications are available:

- Manuel technique d'aménagements de bas-fonds riziocoles au Burkina Faso. 2006, 49 p. + annexes
- FAO and WARDA, 2005. FAO-WARDA Workshop on Integrated Irrigation Aquaculture, Bamako, Mali, 4-7 November 2003, FAO, Rome, 44 p.
- FAO and WARDA, 2006. Integrated irrigation and aquaculture in West Africa: concepts, practices and potential, FAO, Rome, 181 p.

These IPGs are obtained through various research endeavors, workshops and/or symposia with national and international participation. WARDA conducted a community vulnerability assessment in Côte d'Ivoire and did a needs assessment study in Nigeria. The effect of HIV/AIDS on household assets in Benin was studied. A regional workshop was organized in 2005 and a regional strategy for SSA was developed.

The Meta-Review of CGIAR SWEPS in 2006 noted that there is no evidence of value added to SWIHA through inter-Center collaboration to maximize CGIAR Centers' comparative advantage. IFPRI operates a HIV/AIDS program outside the purview of SWIHA. SWIHA has not been subject to a CCER, there is no formalized M&E process. SWIHA has achieved only limited success to date as a SWEP in achieving its goal and meeting its priorities, given that it has been operational for six years. Its success has largely been derived from its position as a component of WARDA's regional programme and this is more apparent from activities that are more recent in the 2005-2006 period, including the establishment of ANEHA as a modality for programme delivery across SSA.

The Panel, while recognizing the importance of HIV/AIDS in SSA and its effects on the farming population and the role of improved nutrition in mitigation efforts, does not understand why WARDA needs to take the lead in this commendable effort. WARDA is the smallest of all CGIAR Centers with a stagnant budget in real terms over the last five years. WARDA does not have a comparative advantage in taking the lead in this effort, which is very much about sensitization, awareness, and social science research and impact assessment; and there are no synergies with its research program. *Because the System Wide Initiative on HIV/AIDS (SWIHA) is not expected to contribute to WARDA's core research outputs, the Panel recommends that WARDA transfer its convening role to a partner more suited to leading the SWIHA initiative.*

#### **4.2. Links with other CGIAR Centers and Challenge Programs**

WARDA collaborates closely with IITA in plant protection, since most of IITA's researchers in this area are based in Cotonou, e.g. on insect pests of rice in Africa. Many of these pests also occur on maize, such as stem borers, and storage insects. IITA's biodiversity (insects) resource centre is in Cotonou and a mass insect rearing facility is in Cotonou. There is also collaboration in impact assessment. Collaboration with other CGIAR Centers occurs mainly through the networks such as IVC and SWIHA.

Regarding the Challenge Programs (CP), the GCP is discussed under genetic improvement. Idem for the Harvest Plus CP. For the SSA-CP, WARDA represents the CGIAR on the Steering Committee. WARDA participated in the competitive bidding for the Kano-Katsina-Maradi pilot side but did not prevail.

In the CP Water and Food, WARDA coordinates the African site. The Community-based Fish Culture in Irrigated Systems and Seasonal Floodplains (CBFC) project is implemented in five countries: four in Asia and one in Africa. WorldFish coordinates the Asian sites, WARDA the African in Mali, with IER – Mopti in charge. There is the possibility for a second African site in Senegal, which will probably start in 2008. The project started with an inception workshop in June 2005 in Penang, Malaysia. The kickoff was rather slow, which may be due to a frequent change of coordinators in Penang. Activities accomplished so far are: questionnaires were developed and unified across sites, and translated and tested in Mali; a relational database was



developed at WorldFish allowing for cross country analyses; the database was translated by WARDA into French and tested in Mali; two villages were selected in Mali; a detailed livelihood baseline study was completed in both villages; and frequent household surveys started in both villages and integrated rice – fish culture interventions started in one of the villages.

As part of the alignment process, WARDA is collaborating closely with IITA, and will soon be responsible for providing the corporate services at the Cotonou site. The alignment process with IITA concerns: governance: with two shared Board members; corporate services; programs, resulting in a common regional MTP for WCA. The details of governance and corporate services alignment are discussed in chapter 6.

At the same time, programmatic alignment and closer collaboration is planned with IRRI and CIAT. At WARDA's last BOT meeting, three IRRI BOT members were present, including the chair and vice-chair and a member from SSA. They presented ideas and areas where synergy from collaboration would be significant. It is to be noted that at the first African Rice Congress in 2006 in Dar-es-Salaam, presence and presentations from IRRI and CIAT researchers were prominent and well appreciated.

WARDA-IRRI-CIAT collaboration will be focused on the following areas: genetic resources/seed strategies, biotechnology, genomics, MAS, post-harvest technologies, value chain development, policies, training and enhanced information sharing. A joint project financed by the Gatsby Foundation concerns the collection of local landraces of rice in Uganda, Kenya, Tanzania and Mozambique. Another activity funded by IFAD is a Program for alleviating Rural Poverty through Improving Rice production in ESA. It is proposed to establish a SSA Rice Consortium (SARC) to consolidate technology development and dissemination, conduct trainings, increase partners' involvement in technology development and dissemination, constitute a strong post-harvest technology working group by appointing an Africa-wide expert and enhance information sharing and develop an African Rice Knowledge bank (in English and French).

Canada (CIDA) has given CAD 300,000 for a conference/workshop, held in June 2007, and follow-up to develop a comprehensive strategy for programmatic collaboration and for developing joint research proposals.

*On the WARDA-IRRI collaboration and the question of competing interests*, WARDA and IRRI are not competing, but are instead now forging alliances. An IRRI breeder is already posted at WARDA in WCA. Similarly, IRRI-WARDA-CIAT are developing a strategic alliance in which each Center's comparative advantage will be taken into account. These comparative advantages based on ecological geography and expertise in particular environments, constraints and rice types are complementary. Integration is planned across genebanks that hold crops in common. Activities to be included in Center MTPs include joint development of an information system integrating the rice genetic resources of IRRI, WARDA and CIAT, and a global system of germplasm exchange based on INGER is proposed among other planned joint proposals and joint positions. A workshop was held in June 2007 to map out a strategic alliance to ensure that the Centers work effectively to produce synergy, economies of scale and sharing of scientific expertise. A lot of collaboration is already happening through the IHP project, GCP, and the posting of an IRRI breeder at WARDA. WARDA has developed a MOU with IRRI and with ASARECA for the establishment of ECARRN hosted by WARDA. IRRI has already placed a production specialist in Maputo, Mozambique who is IRRI Regional representative for the ESA region and program leader for IRRI's program 3. He is already conducting trials in crop

management and crop protection. The future plans of IRRI include the expansion of the program to ESA countries. *The Panel strongly encourages the WARDA-IRRI-CIAT programmatic alignment in the specified areas.*

*The SC issue whether in its partnership with IRRI WARDA is capturing the "non-African" specific products and knowledge for the improvement of upland, rainfed and irrigated rice, especially since this is critical for such constraints as drought and nutritional enhancement, which are generic to all continents?* Issues regarding drought and nutritional enhancement are covered in detail in the genetic improvement section. The partnership with IRRI and CIAT is being strengthened as outlined before. Germplasm exchange, including through INGER-Africa, has been actively carried out between WARDA, IRRI and CIAT, especially for interspecific materials. IRRI's aerobic rice varieties comprise an important part of the materials for research of one Japanese post-doctoral fellow at WARDA, who is seeking high-yield varieties and plant types for the rainfed ecology in WCA. Another post-doctoral fellow is working within the Rockefeller-funded drought project at WARDA using both aerobic and upland rice varieties from IRRI, among other varieties, in this trials and crosses with the aim of identifying drought QTLs and producing drought-tolerant breeding lines. Unfortunately, everything tends to be branded "NERICA" at WARDA, even if only *O. sativa* products are involved. Thus, there is more to the collaboration with IRRI regarding the use of its germplasm (capturing "non-African" specific products) than one tends to see at WARDA.

*On the SC issue whether in the partnership with AVRDC and others for diversifying rice-based production systems with livestock, fish and vegetables, is the work carefully focused, so that it does not dilute WARDA's efforts, and is it supported by appropriate socioeconomic research? Does WARDA have a clear rationale for its involvement in the diversification and move in this direction?* The rationale behind WARDA's collaboration with AVRDC is derived from the fact that diversification in rice-based systems through high-value vegetables can improve farmers' income and increase their ability to respond to market demand. Insertion of vegetables in irrigated rice systems can stop the decrease in agricultural productivity affecting such irrigated rice schemes and increase their economical performance. Moreover, vegetables were rated by CORAF for the Sahelian environment as the most important crop, just before rice. Nevertheless, WARDA needs to move cautiously in its partnership with AVRDC to diversify the rice-based systems in order not to lose focus on its core competence in rice research. Regarding livestock and fish, caution has also to be applied because they involve different production systems. There is an externally funded project on community-based fish culture in irrigated systems and seasonal floodplains with IFPRI and WorldFish in the framework of IVC.

WARDA and AVRDC forged an alliance with a joint MOU and have addressed research issues in rice-vegetable systems since 1992. Active work has been carried out, with AVRDC posting a scientist at WARDA when the main collaborative project was initiated in 2003. With the "Ivorian crisis", the collaboration was somewhat affected. However, the director-generals of AVRDC and WARDA have agreed to enhance the collaboration. AVRDC plans to post a vegetable agronomist at WARDA, for active involvement in both the Global Horticultural Initiative and the new Challenge Program on Fruit and Vegetables. The use of nutritious vegetables from rice-vegetable systems can be of great value to poor populations and those nutritionally affected by diseases such as HIV/AIDS.

#### 4.3. Links with Advanced Research Institutes

WARDA has many links with advanced research institutes, particularly in genetics, breeding and biotechnology (Cornell University, IRD, John Innes, Nihon University, JIRCAS, CIRAD, University of Tokyo, University of Kyoto, University of Montpellier, YAAS, JICA) and NRM (mainly through the IVC: ITC, WUR, Bonn, CIRAD). In molecular breeding in particular, there is strong collaboration with IRD, Cornell, IRD/CIAT, NIAS, particularly through the research consortium for drought of rice. All these partners were present at the first African Rice Congress in 2006 and made presentations. It is also expected that through closer collaboration with IRRI and CIAT, more links can be developed with their Advanced Research Institute partners. In order to gain better insights in existing seed systems, collaboration is planned in anthropology with WUR (for Guinea and Sierra Leone), in sociology with Cornell (Ghana and Sierra Leone) and in innovation systems approach with the United Nations University (Benin and Guinea). Areas where more collaboration with Advanced Research Institute partners is desirable are water management, soil fertility and agronomy, weed science, mechanization, crop physiology, modeling, spatial analysis and rice policy analysis.

*The Panel commends WARDA for its long lasting collaboration with Advanced Research Institutes and encourages them to further enhance its links on rice research in Africa and in this way gain more strength and critical mass. Attendance at International Conferences and meetings, joint research programs and publications, sabbaticals at WARDA, visiting scientists and other tools for stronger and deeper collaboration need to be facilitated. A specific budget needs to be made available for developing such enhanced collaboration.*

#### 4.4. Links with NGOs, civil society and the private sector (seed partnerships)

WARDA is very keen on developing partnerships at all levels with CSOs (Civil Society Organizations, including NGOs, farmer associations, private sector operators, etc.). WARDA, as an association of Member states, cultivates ownership locally. During field visits, we were impressed by WARDA's good links with CSOs.

The methodologies elaborated or adopted by WARDA favor participation of local groups such as PVS, CBSS, PLAR-ICM. In most cases, WARDA works with local NGOs and farmer groups on an informal basis. A formal agreement is usually only made for seed production under contract. The PADS project (Participatory Adaptation and Diffusion of technologies for rice-based Systems) financed by IFAD is now in its second phase in The Gambia, Guinea, Ghana and Mali. Through participatory field experimentation, demonstrations and a seed multiplication program, the PADS project has brought thousands of farmers into contact with WARDA's NERICA for use in low-input rainfed systems. The PADS project has also focused on post-harvest issues, including improved paddy and seed storage and processing. The project uses the PLAR methodology. PLAR has enabled the possibility of a Rural Knowledge Center where the interested farmers can be trained as facilitators and can (partly) take over the role of the governmental (or NGO) facilitators.

NGOs with whom WARDA collaborates are ADAF-Galle in Mali, SG 2000 Mali, SG 2000 Guinea, SG 2000 Uganda, Doubei International in Côte d'Ivoire, COPRORIZ farmers' union in Bouaké, Côte d'Ivoire, ACOPCI in Côte d'Ivoire, and OVDL in Côte d'Ivoire. An agreement was signed between WARDA and Sasakawa Global 2000 for collaborative work in Africa. In Benin, an agreement was signed with Songhai, a local farm and NGO.

#### 4.5. Conclusions

A CCER on partnerships was conducted in 2004. It commended WARDA's partnership model and recognized that a key WARDA strength lies in its partnerships and the ability to work closely with national programs, NGOs and farmers from priority setting to implementation of programs and projects. The outcomes of the partnerships are unquestionably positive. In its various partnerships and linkages, WARDA often operates as a facilitator, a broker, a service provider, an advocate, even as a trusted friend. WARDA is special and unique in the CGIAR because of the ownership partners have in WARDA. This became very clear through the CCER's and in the field visits. **"WARDA, that is us"** typifies this special relationship. In addition, on the many questions regarding critical mass, which the Panel asked WARDA staff, responses invariably included NARS scientists through the various partnerships and networks.

Nevertheless, partnerships come at a cost and sometimes transaction costs are high. It depends very much on the strength of the partners, the financing available and the prevailing policy framework. However, clearly, partners look at WARDA for scientific leadership, science quality and strategic leadership besides the products of research in terms of genetic resources, agronomic recommendations, research protocols, publications and capacity building. This is where the programmatic alignment with IITA in WCA and with IRRI and CIAT in rice research comes in. It can mean a boost in the catalytic role, which WARDA is playing in the region. WARDA's specific role in the partnerships undoubtedly has to move upstream – more strategic research, more good science, and capacity building – while the various partners adapt and tailor the technologies and approaches to the local conditions and circumstances. At the same time, WARDA needs to learn more from the partners, from field experiences and the downstream G X E interactions, and use this feedback more intelligently in its own research. Overall, WARDA embraces and values its networks and partnerships very much, and this is to be commended. "Partnerships at all levels" is a WARDA saying; and it is not an empty phrase.

## 5. ADOPTION AND IMPACT

A first issue to clarify is the definition of “adoption”. From what we understood, adoption is defined by the willingness of a farmer to test a new accession, but it seems important to see how long the variety is grown in the farmer's fields. If the new variety is tested for one season and discarded after that, one can hardly call that adoption. The number of years the variety is grown as well as the variation in surface under rice should be monitored.

WARDA conducts three types of adoption studies: adoption of modern rice varieties, yield impact studies and socio-economic impact studies on the effects of adoption. In all the kinds of studies WARDA takes a “snapshot approach”, i.e. adoption is assessed at a fixed point in time, and as declared by farmers. Yield stability over time of modern varieties and better agronomic practices are not studied. In addition, the effects of paddy rice prices paid to farmers are not considered as a factor of adoption in the studies.

### 5.1. A new methodology for adoption studies

Adoption studies conducted at WARDA provide estimates of potential and actual NERICA adoption rates and their socio-economic determinants using a new methodology<sup>96</sup> based on the “counterfactual outcomes framework”. It enables one to assess the intrinsic merit of a new technology in terms of its potential demand by the target population separated from issues related to dissemination and access to the technology (which are usually beyond the realm of research). This methodology is called “Average Treatment Effect Estimation of Adoption (ATE)”. A software tool that implements the new methodology in Stata has also been developed. Notwithstanding the deficiencies in adoption studies mentioned above, the Panel commends WARDA for this new methodology.

WARDA in 2001-2002 conducted a major study of the economic impact of improved rice varieties from both national and international research Centers on all West African rice ecologies. The study estimated that genetic enhancement and transfer has increased the value of rice production by US\$ 93 per hectare.<sup>97</sup> The study also confirmed that while irrigated and rainfed lowland ecologies have largely benefited from varietal improvements, upland rice-farming systems stayed behind due to much lower rate of adoption and the limited gain in yield. Results from more recent surveys (2003) conducted by WARDA confirm the very low uptake of modern varieties in upland ecologies due to their very low diffusion. IRRI found similar results in some of the poor upland rice ecologies in Asia.

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<sup>96</sup> The paper entitled “Taking a New look at Empirical Models of Adoption: Average Treatment Effect Estimation of Adoption Rate and its Determinants” contains all the technical details of the new methodology, including (a) the formal demonstration (i.e. mathematical proofs) of the statistical properties of the new estimators of adoption, (b) the reasons why the classical adoption model yields biased and inconsistent estimates of adoption rates and extremely small and statistically insignificant estimates of socio-economic determinants of adoption; and (c) a side by side comparison of empirical results (using the NERICA data) obtained from the new methodology and from the classical model.

<sup>97</sup> Dalton, Timothy J. and Robert G. Guei, 2003. “Productivity Gains from Rice Genetic Enhancements in West Africa: Countries and Ecologies”. *World Development* 30, No 2, pp. 359-374.

It is to be noted that the Meta-analysis of the CGIAR impact of crop genetic research (2005) resulted in a present value estimate of total potential benefits of 321 million US\$ for rice for WARDA and its NARS partners<sup>98</sup>.

## 5.2. Adoption and impact studies

WARDA, in collaboration with the national partners, is conducting adoption and impact studies using a common methodology in nine countries of West Africa, namely Benin, Côte d'Ivoire, The Gambia, Ghana, Guinea, Mali, Nigeria, Sierra Leone and Togo. Three of these nine studies have been completed<sup>99</sup>. Datasets have been developed for the concerned countries and papers presented at international conferences or are being published. Table 5.1 below, summarizes the major findings in the three countries where the studies have now been either fully or partially completed.

In Côte d'Ivoire, a low diffusion rate (9%) limited the adoption of the NERICA lines to just 4% of the farmers in the sample in 2000. However, the adoption rate in the population could have been up to 23% if the whole population had been exposed to the NERICAs. The rate of NERICA diffusion was 40% in Guinea—much higher than in Côte d'Ivoire. The NERICA population potential adoption rate (had all the farmers in Guinea been exposed to the NERICA) is 59%, double the actual adoption rate observed in the sample (23%). Up to 53% of farmers with exposure to NERICA lines had adopted them in 2001. In Benin, the NERICA diffusion rate in 2004 was 26%. NERICA lines were adopted by 18% of the farmers in the 2004 sample, an adoption rate three times lower than the estimated potential adoption rate of 57%. Up to 70% of farmers, who were exposed to NERICA lines in Benin in 2004, have adopted them.

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<sup>98</sup> See also: "Crop variety improvement and its effect on productivity The impact of international agricultural research", edited by R.E.Evenson and D.Gollin, CABI Publishing, 2003.

<sup>99</sup> Diagne Aliou, 2007, "Bred for Women Rice Farmers? Impact of NERICA Adoption on Rice Yield in Côte d'Ivoire", in revision for Experimental Agriculture.

Agboh-Noameshie, A.R., F.M. Kinkingninhoun-Medagbe and A. Diagne, 2007, "Gendered impact of NERICA adoption on farmers' production and income in central Bénin", Contributed paper accepted for presentation at the Second Conference of the African Association of Agricultural Economists, August 20-22, 2007, Accra, Ghana.

Adegbola Patrice, Y. Aminou Arouna, Aliou Diagne et Souleïmane A. Adekambi, 2006, "Evaluation de l'impact économique des nouvelles variétés de riz NERICA au Bénin: Evidence avec les modèles basés sur l'approche contre factuel". Paper presented at the First African Rice Congress, Dar es Saaam, Tanzania, July 31-August 4, 2006.

Diagne Aliou, Marie-Josée Sogbossi, Sekou Diawara, Abdoulaye Sadio Diallo et Alpha Bacar Barry, 2006, Evaluation de la diffusion et de l'adoption des variétés deriz NERICA en Guinée, Contributed paper accepted for presentation at the second Conference of the African Association of Agricultural Economists, August 20-22, 2007, Accra, Ghana.

<b>Table 5.1 Summary results of the adoption and impact studies in three countries</b>			
<b>Category</b>	<b>Benin (Centre)</b>	<b>Cote d'Ivoire (4 regions)</b>	<b>Guinea (whole country)</b>
Average adoption rate of NERICA by farmers in sample (year)	18% (2004)	4% (2000)	23% (2001)
Average adoption rate, had all farmers been exposed to NERICA (year)	50% (2004)	27% (2000)	58%
% of farmers adopting after being exposed to NERICA (year)	68% (2004)	38% (2000)	53% (2001)
NERICA diffusion rate - % exposed to NERICA (year)	26% (2004)	9% (2000)	39% (2001)
Estimated area under NERICA (year)	1995 ha (2003)	-	51,000 ha (2003)
Average NERICA yield impact for all farmers (year)	1,587 kg/ha (2003)	276* kg/ha (2000)	.085* kg/ha (2003)
Average NERICA yield impact for female farmers (year)	850 kg/ha (2004)	741 kg/ha (2000)	
Average NERICA yield impact for male farmers (year)	517 kg/ha (2004)	-134* kg/ha (2000)	
Impact on per capita rice income per year	CFA 14,100 (2003)	-	-

\*Not statistically different from zero at the 5% level

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

### 5.3. Determinants of adoption

The results of the analysis of the socio-economic determinants of NERICA adoption in Côte d'Ivoire (2003) in four regions, including uplands and lowlands, show that the main factors affecting the adoption of NERICA were: growing rice partially for sale (positive impact), household size (positive), age (negative impact), having a secondary occupation (negative impact), growing upland rice (positive impact), past participation in PVS trials (positive impact) and living in a PVS-hosting village (positive impact). In Guinea, the main socio-economic determinants of NERICA adoption with positive effects were participation in a training program and living in a village where the SG2000 has had activities. In Benin the main socio-economic determinants with positive effects were land availability and living in a PVS-hosting village. In addition, it was also found in Benin that varietal attributes such as swelling capacity and short growing cycle were important determinants of NERICA adoption.

The ATE adoption model<sup>100</sup> shows the PVS to have played a major role in the adoption of the NERICAs. The finding that the mere conduct of PVS trials in a community promotes the adoption of NERICAs beyond the subpopulation participating in the trials points to a possible

<sup>100</sup> Diagne Aliou, "Taking a New Look at Empirical Models of Adoption: Average Treatment Effect Estimation of Adoption Rates and their Determinants", 26th Conference of the International Association of Agricultural Economists, August 12-18, 2006, Gold Coast, Australia and European Meeting of the Econometric Society, August 24-28, 2006, Vienna.

strategy for scaling-up PVS: focus on covering more villages with relatively few PVS participants per village (i.e. inter-village scaling-up) and let the naturally occurring phenomenon of “social learning” about the characteristics of a technology do its work within the village community (i.e. the intra-village scaling-up).

#### 5.4. Constraints to adoption

One would expect rapid diffusion and adoption of NERICA varieties in SSA. However, the record of spread of NERICAs is rather sobering. Presently, there are an estimated (by WARDA) 150,000 ha of NERICA in SSA, about (50,000 to) 100,000 ha<sup>101</sup> in Guinea (Conakry), about 25,000 – 35,000 ha in Uganda. There is a large uncertainty associated with these area figures. In total, there are 9 million ha of rice in SSA<sup>102</sup>, and about 4.7 million hectare in West Africa, of which 1.8 million upland, or 38.3%. There are about 120,000 ha under NERICA in the uplands in West Africa. Thus, about 6.7 % is under NERICA. This is not surprising after 5 to 10 years of diffusion. Many constraints operate on the diffusion and adoption of NERICAs. Availability of NERICA seed (and complementary technologies) is a big issue as the Nigeria study commissioned by the Rockefeller Foundation/Gatsby Foundation/WARDA (reference below) showed and also the WARDA CCER of NERICA Impact in Guinea by Jacques Brossier (reference below). But also the rice quality issue linked to post-harvest operations is a major constraint resulting in low(er) prices when farmers sell paddy. In addition, many other rice characteristics play a role besides yields per se.

Through all the studies WARDA has conducted over the years on the constraints to adoption (of NERICA), the following has been learned:

- farmers have to be exposed (information) to the merits of NERICAs, otherwise there is no adoption;
- there is limited farmer-to-farmer adoption, i.e. NERICA's do not spread by themselves from areas or places where adoption has occurred, as is usually the case in Asia;
- availability of (cheap) NERICA seed (requiring government support if the private sector is not performing) is a condition for adoption and growing. Lack of seed often results in disadoption by farmers that have grown NERICAs.<sup>103</sup> Difficulty in obtaining affordable seed is the major reason given for abandoning WARDA varieties. Also, seed shortage is the major reason given for non-adoption of WARDA varieties;
- the main advantages of NERICAs are not high yields per se but rather early maturity, tolerance to water stress, good taste and flavor, short straw. The same attributes in other localities may explain non-adoption. Thus, NERICA adoption effect on farmers' yields is heterogeneous with some farmers not experiencing any yield increase when adopting NERICA. One of the stated advantages of NERICA, strong early vegetative growth and weed suppression, reducing the need for weeding, was not confirmed in the field visits; some of the advantages in some places become distinct disadvantages in other places;

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<sup>101</sup> These are probably the lower and upper limits of NERICA adoption according to the WARDA. See Brossier, Jacques, Evaluation of the impact of NERICA rice varieties in Guinée", CCER WARDA, July 2007.

<sup>102</sup> FAOSTAT

<sup>103</sup> Spencer Dunstan, Andrew Dorward, George Abalu, Dayo Philip and Diji Ogunbile, "Evaluation of Adoption of NERICA and other Improved Upland Rice Varieties following Varietal Promotion Activities in Nigeria", A study for the Gatsby and Rockefeller Foundations, Final Report, January 2006.



- many farmers grow traditional rice varieties alongside improved varieties.<sup>104</sup> Doumbia found that in the Daloa department of Côte d'Ivoire, 30 rice varieties are known and grown by farmers. In the region of Gagnoa, more than 10 rice varieties are grown in a lowland rice scheme;<sup>105</sup>
- early maturity can lead to massive bird damage if only a few farmers grow NERICA in a locality; bird damage on NERICAs is often given as a major constraint; and
- short straw implies bending over by women harvesting rice by the sickle and is more painful and difficult than for long straw rice. Short straw is a disadvantage if straw is used as animal feed, or if it is used for other purposes, such as roofing.

*According to WARDA and the SC*, shortage of seed remains a main constraint (SC Q 4). WARDA addresses it as a research component rather than as a simple service element. Other structures such as ARI, PASS (Program on African Seed Systems) or the African Seed Network are also involved. ARI has been created specifically to address the seed issue. Seed issues are discussed in the next section.

The Panel found limited evidence that WARDA really draws the appropriate lessons from these constraints to adoption and adoption studies. WARDA must mainstream social sciences research regarding adoption in the technology generation programs, ensuring better integration and feedback.

*Because technology generation must take into account the heterogeneity of the environments and the farming populations, including the different needs of farmers, for better targeting of technologies and better adoption, the Panel recommends that WARDA, in its adoption and impact studies, involve suitable interdisciplinary teams from its research program (breeding, natural resource management, socio-economics).*

As we simply do not know, even by a large approximation, the area under NERICA, and since this is important for the overall strategy of WARDA, impact assessment and research guidance, WARDA needs to set up a small, cost-effective project to measure the area under NERICA and other improved rice varieties in the key countries where these are grown and expanding. This needs to be a continuing activity, part of impact assessment. Collaboration with FAO Statistics (FAOStat) and with the national statistical offices is advised. The key countries are presently: Guinea, Uganda, Nigeria, Côte d'Ivoire, Burkina Faso and Benin.

Ideally, the annual agricultural statistics surveys should be complemented with a specific question on the area under NERICA and other improved rice varieties and key agronomic practices in the main rice growing areas. With carefully designed sample surveys, it will be possible to extrapolate to the national level and maintain overall statistical reliability. Enumerators will have to be trained in the identification of improved varieties, as distinct from traditional rice varieties, and in the importance of undertaking this effort. Such a project is best initiated through a workshop organized by WARDA, convening all heads of (agricultural) statistical offices of the countries concerned, with key resource persons from FAO and possibly

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<sup>104</sup> Doumbia, Sekou, Enquête bilan de l'état de l'adoption des variétés améliorées de riz pluvial dans le département de Daloa Zaguiguia 2006, CNRA Abidjan, Novembre 2006.

<sup>105</sup> Doumbia, Sekou, I.J. Keli et M.E. Depieu, "Perception paysanne de l'innovation à travers l'évaluation participative en riziculture: intérêt et limite pour la recherche", *Agronomie Africaine*, No spécial (5), 2004.

IFAD and AfDB and regional economic organizations, and participation of ROCARIZ. The workshop proceedings would then form the basis for the project document, to be submitted to donors. As stated, the project should not be a one-off exercise but have a duration of at least five years.

*The Panel suggests that WARDA convenes a workshop, with participants from the agricultural statistical offices of the countries with a large area of rice under improved varieties, from ROCARIZ and collaborating international institutions, with a view to designing and implementing a project to measure, in a statistically reliable and cost-effective way, the rice area under improved rice varieties and the prevailing agronomic practices.*

## **5.5. Impact culture and measures of impact**

Following the 4<sup>th</sup> EPMR recommendation that WARDA strengthen its capacity to monitor and assess the impact of its activities, WARDA engaged a full-time adoption and impact assessment economist. He works very closely with national partners, supplies software, provides training and backstopping in impact methodologies and in data collection. He has the help of a visiting scientist. In 2006, he spent US\$ 130.000 on adoption and impact assessment studies, most of these funds going to NARI collaborators in the ROCARIZ network. Maybe studies should be done in fewer countries to allow for more in-depth studies.

The impact assessment is conducted under four broad themes:

- Impact of modern varieties on farmer livelihoods and rice bio-diversity;
- impact of improved crop management practices on farmers' livelihoods;
- impact of improved grain quality and post harvest technologies on the rice sector; and
- developing regional capacity in impact assessment through training and joint implementation of collaborative projects.

The main components of the methodology consist of:

- Community and household surveys on knowledge and adoption of varieties and on seed acquisition;
- household and plot levels surveys to collect data on areas and yield by variety, input use, income, food intake, children's schooling, etc.;
- country-wide census or survey data on rice areas and farm populations;
- estimation of dynamic models of adoption based on the ATE methodology;
- estimation of impact on various household-level outcomes based on the ATE methodology; and
- estimation of ex-ante and ex-post impacts on economic and environmental outcomes at the national and continent-wide levels.

Because large datasets are collected, analysis is time consuming. By the end of 2008, the nine ongoing adoption and impact studies will be completed, and it is planned to hold a workshop, resulting in the publishing of a book on adoption and impact. This is to be commended.

The SC Performance Management Results indicators 2006 show for WARDA a very good score (52.6/70) for IA, a very low score for building an IA culture (6.5/20), an excellent score (7.8/8) for communication/dissemination & capacity building and a good total adjusted score of 7.4/10, the third highest in the CGIAR system. One can state that there is an impact culture of social scientists at WARDA with their partner social scientists in the NARS. However, WARDA is the

second last in the CGIAR system (just before CIAT) for building an IA culture within the Center. This implies (in the IA performance measurement for building an IA culture) the organization of internal workshops, systematic evaluation of user relevance, use of IA in planning/priority setting and baseline studies. Mainstreaming IA throughout WARDA is thus still a major challenge. *The Panel confirms that building an IA culture at WARDA leaves a lot to be desired and remains a challenge. WARDA should take the necessary action to build an IA culture in the Center.*

Yield impact is still the main indicator, including in uplands. Impact in terms of improved food security, reduced poverty, better schooling of children, longer life expectancy, etc. is much more difficult to assess, needs a longer-term perspective and a much larger adoption of improved varieties. WARDA has started to conduct such studies<sup>106</sup>.

## 5.6. Institutional innovations in seed systems

In 2001, WARDA initiated an innovative participative approach called community-based seed systems (CBSS) to ensure seed access at the grassroots' level. Activities funded by UNDP were coordinated by government extension services – in Côte d'Ivoire by ANADER and in Guinea by SNPRV. The project engaged directly with NGOs and farmer groups. Small quantities of NERICA seed were handed to farmers and accompanied by training in seed production. Farmers thereby became sources of quality seed in their own communities. Seed producers' major constraints were: drying paddy rice during the rainy season; threshing NERICA 4 is very difficult; damage caused by pests (grasscutters, rats, insects and birds); seed conservation; timely availability of fertilizer supply

Brossier Jacques (2007)<sup>107</sup> in his study on the impact of NERICA in Guinea states the positive impact of CBSS from 2001 to 2004 in the diffusion of NERICAs (with the support of SNPRV, IRAG, SG2000, UNDP and the World Bank and from 2005 on with ARI) but also mentions that private entrepreneurial seed farmers eventually have to take over from CBSS. All important private seed companies in the world (Cargill, Pioneer, Limagrain) started from farmers as seed entrepreneurs<sup>108</sup>. The 2006 Spencer et al.<sup>109</sup> study for Nigeria shows that there are substantial processes of change in seed supply and varietal cultivation ongoing among sampled farmers. It thus has to be an area of constant attention and monitoring by WARDA, also because the international rice market is rapidly changing. In many places, retention of seed of modern varieties from the farmers' own harvest does not seem to be an important seed source and this is puzzling.

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<sup>106</sup> Adekambi, Souleimane, Aliou Diagne et Gauthier Biaou, Impact de l'adoption des varietes NERICAs sur la scolarisation des enfants au Benin: cas du Departement des Collines, 2005.

<sup>107</sup> Brossier, Jacques, Evaluation of the impact of NERICA rice varieties in Guinée", CCER WARDA, July 2007.

<sup>108</sup> During the field trips, we encountered some of these emerging seed entrepreneurs/companies: NASECO and FICA in Uganda, FEPRODES in Senegal, Tunde in Bénin.

<sup>109</sup> Spencer Dunstan, Andrew Dorward, George Abalu, Dayo Philip and Diji Ogunbile, "Evaluation of Adoption of NERICA and other Improved Upland Rice Varieties following Varietal Promotion Activities in Nigeria", A study for the Gatsby and Rockefeller Foundations, Final Report, January 2006.

WARDA is currently engaged in research on the institutional innovations for the emergence and efficient functioning of local, national and regional seed systems. A major constraint is ensuring farmers' timely access to quality seed by setting up sustainable seed production systems at national and community levels. Another technical constraint more at the system level concerns the timely supply of breeder and foundation seed at the national level in order to ensure regular input in CBSS and other local seed systems. The African Rice Initiative (ARI) is currently strengthening NARES capacity in seed production in seven pilot countries, and is fully engaged in producing breeder and foundation seed as national capacities are developed. This production of foundation seed is considered by WARDA as a temporary but necessary intervention for those countries where capacities are still weak. As the seed systems develop, WARDA's role in producing foundation seed will become limited or non-existent. Then only breeder seed will be produced. The Panel is in favor of such an evolution.

WARDA is currently conducting the following studies on seed systems

- Innovation system level. In collaboration with a post-doc from the United Nations University, WARDA is assessing the need for institutional innovations in NERICA seed dissemination at the national and regional levels. The study started in December 2006 and covers Benin, Ghana, Sierra Leone and Guinea;
- a second multi-country study was started in 2006 by a visiting scientist from Cornell University to assess the formal and informal rice seed system pathways in Ghana and Sierra Leone with a view to identifying bottlenecks and points of intervention for improving farmer access to seeds of acceptable quality;
- another study aimed at analyzing the structure and function of farmer seed producer groups in ensuring the access of resource-poor farmers to quality rice seed is being started in Guinea and Sierra Leone in May 2007.

## 5.7. Policy dialogue

Creating a conducive and supportive environment for rice development in SSA is of utmost importance for the attainment of the food security and economic development goals set by the countries and the region. WARDA's social science research agenda is very much focused on more effective policy dialogue as a means to setting a conducive policy environment<sup>110</sup>.

The policy domains affecting the rice value chain can be broadly structured into three categories<sup>111</sup>:

- Market, trade and price policies, including regulations and standards;
- environmental and ecosystem policies; and
- research and development policies for innovations.

WARDA, more than any other CGIAR Center, is well placed to engage in policy dialogue in SSA, through its Council of Ministers (COM), which meets every two years, and its associated National Experts Committee (NEC) (the heads of the NARS of the member countries) which

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<sup>110</sup> We benefited from a monitoring report by Jonathan Coulter and Bohumil Havrland on "Policy Environment and Rice Market Development", project 3.2. (Project 5) for the European Commission, dated November, 2005. The European Commission partly finances policy research at WARDA.

<sup>111</sup> Von Braun, Joachim, Public policy and international collaboration for sustaining and expanding the rice revolution, Keynote at the 2nd International Rice Congress on "Science, technology and trade for peace and security", New Delhi, October 9-13, 2006.

prepares the meetings of the COM. The COM and NEC have made statements giving resounding support to WARDA's policy work. WARDA has made frequent assertions in presentations and publications that the policy environment for rice development in SSA is negative or unfavorable. This by itself can be questioned as most countries practice some form of import protection. However, at the same time, they could do much more for national rice research and development.

It is in the COM in particular that the seed issue has been discussed and that it was decided to create ARI. WARDA's publication on "Rice Trends in Sub-Saharan Africa" is a crucial background statistical document on policy dialogue but it is updated infrequently and contains no analysis. To be effective, it needs to be updated once a year and commented.

Regarding rice development policies, what is also lacking is a continuously updated document on the rice policies in place in each of the Member Countries, as detailed as possible (in a comparative table or overview document). This document should include the rice import policies, policies regarding rice production inputs (seeds, fertilizers, water pricing in irrigated schemes), rice prices to producers and in the market, taxation of rice consumption, the main rice research and development projects, with their budget, regulations and standards affecting the rice sector. *The Panel suggests that WARDA updates its "Rice Trend in Sub-Saharan Africa" annually and prepares and continuously updates a "Rice Policies in the Member Countries" overview document.* Undoubtedly, WARDA could be more effective in policy dialogue, but this is only possible if more and better policy analysis research is conducted (see 2.4. on social sciences in WARDA). WARDA supports the Agricultural Policy Research and Advocacy Group (APRAG), which allows transmittal of research findings to national and regional policy makers.

Attempts to establish a joint appointment on policy research with IFPRI never succeeded. No concrete collaboration has been achieved, although every review of social sciences at WARDA mentions it as desirable. Even in the SWIHA program, collaboration with IFPRI is minimal. It is not clear why such collaboration cannot materialize, but WARDA attributes it to IFPRI's desire to always take leadership and initiative. The WARDA-IRRI recent workshop listed policies as an area of collaboration. Thus, joint efforts should be made to collaborate effectively with IFPRI on rice development policies in SSA.

## **5.8. Conclusions**

The Panel had difficulties understanding WARDA's adoption and impact studies. Unless the agro-ecological and socio-economic context is made clear and explicit, the results obtained are difficult to gauge. There is a danger in adoption and impact studies that are too generic -- .country wide, across all environments. WARDA's approach to adoption and impact studies should not be limited to a snapshot approach of adoption and yield impact. Yield stability over time, adoption of improved agronomic practices and the effect of (rising) paddy prices paid to farmers should also be considered in adoption. WARDA developed a new methodology for adoption studies; the PLAR method for technology transfer; and mainstreamed PVS and CBSS in its partner countries. So many constraints operate on adoption that more interdisciplinary teams from the research program need to be involved in the adoption studies.

Regarding NERICA's, some advantages in one place may be distinct disadvantages in another. The seed issue remains a critical constraint, and WARDA needs to be careful in its judgment how far it can go to meet needs, in line with its comparative advantage as a rice research Center.

There is a great need for better data on areas under modern rice varieties and improved agronomic practices. We suggest a workshop on the issue with all concerned partners as a starting point. Regarding an impact culture and measures of impact, the Science Council indicators show a very good score for WARDA, but also a very low score for building an IA culture at WARDA. To improve on this, impact assessment in WARDA's research program needs to be mainstreamed. Finally, regarding policy dialogue, APRAG is an excellent mechanism but it can only be successful if more and well focused policy research is conducted and if full advantage is taken of the NEC and COM structures at WARDA.

## **6. GOVERNANCE AND MANAGEMENT**

### **6.1. Governance**

#### **6.1.1. Governance structure**

As an inter-governmental organization of 17 African states (four additional States from Central and East Africa have applied for membership), the Africa Rice Center (WARDA) has a unique governance structure. Like the other CGIAR Centers, WARDA has a Board of Trustees (BOT). But in addition, it also has a Council of Ministers of Agriculture, Scientific Research and Higher Education (COM) of Member countries in West and Central Africa. The Member States contribute funds to WARDA, and also make in-kind contributions of staff time and other resources that help strengthen WARDA's research and partnership activities. Currently, the Board meets once every year, and the Council meets once every two years.

A National Experts Committee (NEC), comprised of Directors/Heads of the countries' national agricultural research systems (NARS), which supports the work of the Council, and meets annually (in alternate years this meeting is preparatory to the Council meeting), supports the Council. The operational cost of the Board and its Committees is borne by WARDA. However, the cost of Council and NEC meetings is shared between member States, the country/Center hosting the meeting, and WARDA (which pays for honorariums of NEC members (but not COM members); and does not cover travel expenses for attending the meetings. The Panel considers the total cost to WARDA of the BOT and COM reasonable.

The Director General of WARDA serves as the ex-officio Secretary of WARDA's Council of Ministers, and is an ex-officio member of the Center's Board of Trustees. The Board Chair of WARDA is a special invitee/observer at Council meetings. Both the Council and the Board have their own well defined Constitutions and Rules of Procedure. WARDA's Board and Management thus have to take cognizance not only of the legal agreements and of policies that govern WARDA as an "international Center" funded by the CGIAR and other donors, but also of the policies and deliberations of an "African Center" guided by WARDA's Council of Ministers.

In view of this unusual governance structure -- and the time and effort associated with organizing Board, Council and NEC meetings, each of which is attended by many members -- the WARDA Board of Trustees meets once year. To compensate for the gap between Board meetings, WARDA's Executive and Finance Committee (EFC), comprised of the Chairs of all its committees, meets twice a year, and also conducts business electronically between Board meetings. All other Board Committees -- the Audit Committee, Nominating Committee, and Program Committee (on which all Board members serve) -- meet just prior to the meeting of the full Board, though they too conduct some of their business by phone or email, as needed.

The governance structure of WARDA's Board of Trustees is unusual in a few additional respects as well. According to its Constitution, one-half of its 8-14 members must be nationals of Member states, as must the Director General of WARDA. The Board Chair and the remaining Board members can come from countries that are not represented on the WARDA Council of Ministers; i.e., they can come from non-Member states outside West and Central Africa. In accordance with its Constitution, therefore, since 1987 when WARDA joined the CGIAR, the Board Chair has always been from a donor country or a "non-Member" State in Africa. In addition, the Board has

two “CGIAR nominees” appointed by the Board, usually from important donor countries in North America and Europe.

Since March 2007, the WARDA Board has also had two “common Members” with the IITA Board of Trustees. It is intended that two additional common members will be added to both Boards by the end of 2007, to conform to the agreement “in principle” on aligning the governance structures of these two CGIAR Centers located in West and Central Africa. For facilitating the appointment of common members who meet the requirements of both Boards, the Boards of WARDA and IITA have established a “joint” Nominations Committee, comprised of the Chairs of the Nominating and Program Committees of the two Centers. This joint Committee met for the first time in March 2007 in Cotonou. The respective Executive (and Finance) Committees of the two Centers have also conducted “joint” meetings, as well as video- and phone conferences over the past two years.

WARDA’s Council of Ministers has provided much-needed political backing to the Center during its recent traumatic years, and has helped the Center rapidly and successively (first in Bamako, Mali, and then in Cotonou, Benin) find a new home after its painful relocation from Bouaké. The Council and its Member governments take justifiable pride in being the “highest” oversight body of the West Africa Rice Development Association (WARDA), the sub-Regional “autonomous inter-governmental research association” it had created in 1971, sixteen years before WARDA became a “CGIAR” Center in 1987.

Throughout the subsequent twenty years, the Center has successfully maintained this “dual” (regional/African, as well as international) identity. In recognition of its role in rice research and development in Sub-Saharan Africa, in January 2003 -- following a recommendation of the NEC, endorsed by the WARDA Board of Trustees -- the Center was renamed “Africa Rice Center”. This new name was welcomed by FARA, ASARECA, and CORAF/WECARD; and at the Board meeting in February 2003 in Mali, the CGIAR (through its Director) hailed WARDA’s primary research product, NERICA (New Rice for Africa), as a “flagship of the CGIAR”.

The Panel Chair and one member observed the Board and Committee meetings in March 2007, including their closed sessions, and interviewed all Board members individually; and the Panel Chair also met the Chair of the Council of Ministers, currently the Minister of Agriculture and Water Resources for Nigeria. We have also reviewed some of the extensive documentation available to the Board and the NEC during the past few years, as well as minutes of their meetings. Based on these, the Panel’s overall conclusion is that WARDA’s governance structure, though more elaborate than in other CGIAR Centers, is not unduly burdensome.

We believe the Council of Ministers does not unjustifiably influence the functioning of the Board of Trustees of WARDA, which retains the authority to determine the internal policies and strategy of the Center, and to oversee their effective implementation. The NEC has taken its advisory responsibilities seriously, and has helped disseminate WARDA’s research results and outputs to the NARES of West and Central Africa. The Council and NEC have been invaluable for seeing WARDA through the very difficult years of the “Ivorian crisis”, which, importantly, is not yet over -- since the decision on when and how to return to Bouaké is still pending, and is not expected until 2010 or so. This decision will not be easy, and will need to be endorsed by both the Board and the Council.



In December 2004, the Board of Trustees decided that in order to provide much-needed stability to the research program and staff of the Center, WARDA headquarters would, from January 2005, be temporarily located in Cotonou, Benin, while Cote d'Ivoire would remain the host country of WARDA's permanent headquarters. A move back to Bouaké would be considered only after security, living, and working conditions permit. In April 2005, the Board further decided that WARDA would continue to operate from facilities in Cotonou, Benin, "until such time that hostilities among the different factions in Cote d'Ivoire have ceased, the whole country is under duly internationally-recognized Government, and when conditions have been adjudged to be conducive for WARDA's operations". The assessment at that time (in April 2005) was that "the return to Bouaké/M'bé may take between 3-5 years if not longer". The Panel considers this pragmatic approach of the Board, endorsed by the Council of Ministers, appropriate.

Hence, our overall conclusion is that various components of WARDA's unique governance structure have performed their complementary functions diligently and reasonably well. The size and composition of the Board itself, and the structure of WARDA's Board Committees, are satisfactory — and conform in general with the Center's Charter and Constitution, and with the CGIAR guidelines for Boards. We note also that WARDA's Board operations have improved considerably in recent years, and are well managed; and the support provided by the Board Secretary, in terms of documentation and follow-up of Board discussions and decisions, has been effective. The Panel therefore recommends no major changes in WARDA's governance, or Board structure, size and composition. Some improvements in the way its Committees function could nevertheless be useful, including additional support for the Program Committee, as suggested below.

#### **6.1.2. Governance alignment with IITA**

As noted above, WARDA has faithfully implemented the concepts of "common" Board membership and "joint" Committee meetings with IITA, both of which have been strongly recommended by the CGIAR. The experience of the WARDA and IITA Boards during the past two years shows, however, that the transaction costs of even modest steps in "governance alignment" of autonomous CGIAR Centers are not trivial. Not only do busy Board and Committee Chairs and DGs have to set aside time for extensive consultations and joint planning, but the practicalities of date, place, and logistics have to be suitable for both Centers as well.

For example, despite members of both Executive Committees being available in person at their respective headquarters in Cotonou and Ibadan for the "joint" (video/phone) meeting planned for March 2007, even a phone conference could not take place due to an unexpected glitch in technology. After the aborted attempt, both Executive Committees expressed a strong desire to reschedule this meeting for Fall 2007. However, despite their good intentions, it was clear that arranging a face-to-face meeting of the "Joint Executive Committee" was not going to be easy, primarily due to unavoidable conflicts in the dates and locations of the next scheduled meetings of the WARDA and IITA Boards. (The next meeting of WARDA's Executive and Finance Committee is planned for September 2007 in Cotonou, immediately preceding the meeting of its Council of Ministers, hosted this year by Nigeria; and the next IITA Board and Executive Committee meetings are planned for September 2007 in Dar es Salaam).

Despite these hiccups, the various actions on governance alignment already taken or planned by the two Centers provide evidence of the willingness of both Boards to seek common ground on a variety of issues. The Panel believes that efforts at alignment of governance structures are being

taken seriously by both Centers; and that WARDA and IITA are pursuing these measures so that they could more-effectively guide the alignment of programs and corporate services, both of which are currently underway at the Headquarters and field sites of both Centers, as covered elsewhere in this report. Given the practical difficulties of arranging in-person as well as virtual meetings of common Board members and joint Committees, it seems to the Panel that incremental progress is inevitable -- and perhaps even desirable and necessary -- on such important and sensitive matters as alignment of governance structures of otherwise independent entities.

In this context, the Panel also notes that in November 2006, in response to the possibility of a structural “merger” between WARDA and IITA, the Council of Ministers strongly supported WARDA as an autonomous and independent Center with a unique identity that should not be diluted. Since both IITA and WARDA seek to serve the nationals of countries represented on WARDA’s Council of Ministers, it would be in *both* Centers’ interests to retain the considerable goodwill now present among West and Central African countries towards the two Centers and the CGIAR.

Hence, overall, the Panel is convinced that the current steps towards governance alignment provide sufficient momentum to the more meaningful and potentially beneficial moves toward programmatic and corporate services alignment between IITA and WARDA. More ambitious externally driven plans for organizing “Joint Board” meetings thus need to be made with caution, and need to be justified by convincing arguments that their anticipated benefits to both Centers would outweigh their considerable transaction costs of time and effort. This is even more relevant in the case of WARDA now, in light of the considerable change already weathered by the WARDA Board and Management in recent years, as mentioned earlier.

### **6.1.3. Board and Center leadership**

As noted above, the Panel Chair and one member interviewed most WARDA Board members at the March 2007 Board meeting in Cotonou. Based on these interviews, a perusal of relevant Board documents, and interviews with available senior staff of WARDA, the Panel concludes that during the most troubled period of WARDA’s recent history (from 2002-2005), the Center was generally well served by its leaders. At times, especially during the violence in Cote d’Ivoire in 2002 and 2004, the Center needed decisive leadership in response to an environment of considerable uncertainty and unpredictability; and this was provided by the Director General, with support from key members of the Board, particularly the Chairs of the EFC and Audit Committees.

The move to Bouaké was implemented in September-November 2004, in three phases after security guarantees were provided by the Ivorian government and UN Forces. The two parties to the conflict in Cote d’Ivoire had recently signed a peace agreement, which was expected to hold; and no one could have predicted the outcome of this Agreement, nor of the Board-endorsed decision to return to M’bé. Hence, though it is tempting to second-guess some extremely difficult decisions taken by WARDA Management during the “Ivorian crisis”, the Panel believes that, overall, most WARDA staff and their CGIAR colleagues rightly acknowledge the able leadership provided by the DG, Board, and Council, without which the Center would not have survived in its present form.

The former Board Chair of WARDA led the Center from 2003-2005, and the former Director General was at the helm of the Center's affairs for ten years, 1996-2006. Both individuals had exceptional experience and understanding of the needs of NARS, and of conditions in the West African sub-region. They were fully committed to the cause of WARDA, and deserve credit for seeing the Center through extremely rough times in 2002-2005. They, along with their many colleagues -- on the Board of Trustees, among Center management and staff, and in partner organizations, particularly in the Governments of Mali and Benin -- made sure that most of WARDA's research program activities continued uninterrupted even when the headquarters facilities and staff were being relocated from place to place at short notice.

The Director General and Board Chair were fortunate also to have received the support and dedicated services of their ADG for Research & Development and other Directors, and of WARDA staff (both internationally- and locally- recruited) and their families, without which their leadership would surely have failed. They were also very ably supported by WARDA's many friends and well wishers among the Governments of Cote d'Ivoire, Mali, and Benin; the Chair and Members of the Council of Ministers; key donors of the CGIAR, particularly officials of the French, American, and other governments and agricultural research organizations; the UNDP, UNOPS and other officials who helped evacuate staff from Bouaké; the CGIAR Chair, Director, and Secretariat staff; and many staff of NARES partners and other CGIAR Centers, all of whom provided substantial financial assistance and/or material and moral support as needed.

This is not to say that the entire period 2000-2007 has been one of uninterrupted smooth functioning and effective leadership by all concerned. It appears that during the 2000-05 period, Board leadership in some instances was not as strong as was warranted by the circumstances confronting the Board and WARDA. Given the fact that the Board met only once a year, and the situation in Cote d'Ivoire was fast-moving and fluid, it would have been understandable for the Board Chair to allow a relatively free hand to the Director General to manage the unforeseeable realities on the ground as best as possible. Nevertheless, it appears that during this period the (then) Chair may not have been effective at all times in counter-balancing the strong influence and personality of an energetic and forceful DG, fully immersed in the day-to-day running of the Center.

During the same period, the Board and Director General were surprised by allegations of financial fraud relating to the provision of benefits to the latter, which, after due diligence by an influential donor and the Board's Audit Committee, were resolved in favor of the DG. The costs incurred, in terms of inevitable tension between the donors, Board, and DG, was unfortunately heavy. But relations between the (previous) Board and (previous) DG seem to have returned to normal.

The situation appears to have further improved with the appointment in 2005 of the current Board Chair, who leads with a light touch but with a firm grasp of the Board's business. His collegial attitude encourages open discussion and participation by Board members, and is appreciated by most Board members and staff of WARDA. The strategic orientation of the Board could, however, be improved. However, this requires concerted action not only by the Board Chair, but also by the Chairs and members of the EFC and Program Committee, as well as more relevant "strategic-options" papers presented to the Board by WARDA management and staff.

The current Director General was formerly on the WARDA Board for 4 years, and on the NEC for many more years, before being selected as DG in March 2006 (he assumed office in October

2006), following a transparent competitive search process overseen not only by the full Board, but also by the Council of Ministers and the NEC. He has indicated his preference for open dialogue with members of the Board, Council, and NEC, and intends to delegate authority to WARDA Directors, program leaders, and senior staff. This is a welcome development. The Center is fortunate to have the services of experienced senior managers, many of whom bring an in-depth understanding of the CGIAR and of the current capacities and future needs of WARDA. However, some of these managers are new in their jobs, and need to be given time and space to establish themselves in their current positions.

In terms of Board and Center leadership, the current Chair has indicated that the Nominating Committee should start looking for his successor. However, even if this transition were to take place in the next year or two, the immediate future looks reasonably promising for WARDA. The Panel hopes that the new DG, his Board colleagues, and his team of senior staff will soon settle into a rhythm of effective management that will suit the governance responsibilities and managerial style of every one concerned. This will prepare the ground for further progress on such important aspects as implementing the “new vision” for the Center (see below) outlined to staff by the DG in October 2006, and endorsed by the Board at its March 2007 meeting; implementing the WARDA MTP for 2007-09; and further aligning the Center’s governance, programs, and corporate services with IITA and other CGIAR Centers over the next few years, as planned.

#### **6.1.4. Board size and composition**

During the past six years, WARDA’s Board has had between 12 and 15 members. In recent years, the Board has sought to follow CGIAR guidelines for Board composition, as well as relevant recommendations of CGIAR’s 2006 Stripe Review of Center Governance; and has reduced its size from a peak of 14 members in 2001 to 11 members currently (including the DG, an ex-officio Board member). Table 6.1 shows the nationality, gender, disciplinary background, experience (e.g., in research management, governance, finance etc), and period of service of WARDA Board members during the period under review.

As in all CGIAR Centers, the WARDA Board has sought a “balanced” size and composition--in terms of disciplinary strength, gender, experience, and geographic representation--while at the same time seeking to ensure that it retains sufficient capacity to undertake its primary oversight, fiduciary, and other functions. In so doing, and in accordance with its Constitution, it has also sought Board nominees from Francophone- and Anglophone- member countries of West and Central Africa, as well as other Board members with strong linkages with important donor countries (e.g. Japan), and rice-networks around the globe.

The Panel commends the Board for having taken steps to reduce the size of the Board from 15 to 12 (including the Director General), without compromising on the need for maintaining quality and balance. However, some Board members are busy senior executives of comparable or larger research organizations, and do not seem to have sufficient time to devote to Center business. This constraint is being addressed by the Nominating Committee, for example by the appointment of two Vice Chairs of the Program Committee. Nevertheless, these and other mitigating measures to address the problem will need careful monitoring in coming years. In addition, as the WARDA Board seeks in the near future to strengthen the scientific depth of the Center’s research activities, it would need to draw upon additional scientific expertise, so that it could more effectively discharge its program oversight function. This is further discussed below.



Table 6.1 Africa Rice Center (WARDA), Board Composition 2001-2007 <sup>112</sup>															
Name	Nationality	Specialization	Gender	Nominated by	Year 20..							Committee Membership	Start	End	
Mamadou Diomande	Cote d'Ivoire	Phytopathology/Go vt Official	M	Member State	x								C-PC, M-EFC	Nov- 96	Nov- 01
Dunstan C. S. Spencer	Sierra Leone	Ag Economics	M	Member State	x								C-AC, M-EFC, M-PC	Apr- 99	Apr- 01
Diana McLean	Canada	Ag Development	F	CGIAR	x								M-PC, NC	Apr- 95	Apr- 01
Ryuichi Ishii Akilagpa	Japan	Crop Physiology	M	CGIAR Member	x								V-PC	Oct- 95	Apr- 01
Sawyerr	Ghana	Law	M	State	x								M-PC, M-AC	Jun- 98	Jun-01
Jacob Ayuk- Takem	Cameroon	Agronomy/ Research Management	M	Member Sate	x	x	x						M-PC, AC, NC	Nov- 97	Jun-03
N. Lindsay Innes	United Kingdom	Crop Science Animal Science/ Research	M	CGIAR	x	x	x						C-BOT, C-NC, M-AC, PC, EFC	Jun- 98	Nov- 03
Richard Musangi	Kenya	Management	M	Board	x	x	x	x	x				C-BOT, VC, C- NC, M-AC, EFC	Jun- 98	Jun-05
Kanayo Felix Nwanze	Nigeria	Entomology Civil Engineering/ Manager	M	Ex-Officio	x	x	x	x	x	x			M-EFC, PC	Dec- 96	Nov- 06
Remi Pochat	France		M	Board	x	x	x	x	x	x	x		C-AC, M-EFC, PC	Apr- 01	Apr- 08

<sup>112</sup> Notes: \*Members for only part of 2007, hence not counted in total. Their replacements have already joined the Board, and are counted in the total of 11 members in 2007.

C = Chair  
M = Member

BOT = Board of Trustees  
AC = Audit Committee

VC = Vice Chair  
PC = Programme Committee

EFC = Executive and Finance Committee  
NC = Nominating Committee

Table 6.1 Africa Rice Center (WARDA), Board Composition 2001-2007 <sup>112</sup>														
Name	Nationality	Specialization	Gender	Nominated by	Year 20..							Committee Membership	Start	End
					01	02	03	04	05	06	07			
Clementine L. Dabire	Burkina Faso	Entomology	F	Member State	x	x	x	x	x	x	x	V-BOT, C-NC, M-EFC, PC	Apr-01	Apr-08
Takeshi Horie	Japan	Breeder/ Research Management	M	Board	x	x	x	x	x	x	x*	C-PC, M-EFC, NC	Sep-01	Sep-07
Mary Uzo Mokwunye	Nigeria	Horticulture	F	Member State	x	x	x	x	x	x	x*	VC-BOT, C-NC, M-PC	Apr-01	Apr-07
Edwin C. Price	USA	Agric Economics	M	Board Member	x	x	x	x	x	x		VC-BOT, C-NC, M-EFC, PC	Jun-00	Jun-06
Bamba Gue Papa Abdoulaye	Cote d'Ivoire	Socioeconomics	M	State Member		x	x	x	x	x	x	M-PC, M-AC, V-NC	Sep-02	Sep-08
Seck Emmanuel	Senegal	Agric Economics	M	State/Ex-officio			x	x	x	x	x	VC-PC, M-EFC, PC	Apr-04	11-Oct
Owusu-Bennoah	Ghana	Soil Science/ Research Management	M	Member State				x	x	x	x	C-PC, M-EFC, NC	Apr-04	Jun-10
Gaston Grenier	Canada	Agronomy/ Management	M	Board				x	x	x	x	C-BOT, C-EFC, M-AC, PC, NC	Apr-04	Jun-10
Inga Bjork-Klevby	Sweden	Business Admin/ Diplomacy	F	Board					x			M-PC, NC	Mar-05	Mar-06
Tsedeke Abate	Ethiopia	Entomology/ Research Management	M	Board							x		Mar-07	Mar-10
Barbara Becker	Switzerland	Agroecology/ Academia/ Management	F	CGIAR							x	VC-PC, M-NC	Mar-07	Mar-10
Getachew Engida	United Kingdom	Accounting/CG Management	M	CGIAR							x	M-AC, M-PC	Mar-07	Mar-10
												VC-AC, M-PC	Mar-07	Mar-10

Table 6.1 Africa Rice Center (WARDA), Board Composition 2001-2007 <sup>112</sup>														
Name	Nationality	Specialization	Gender	Nominated by	Year 20..							Committee Membership	Start	End
Adama Traore	Mali	Vet. Science/NARS Mgt	M	Member State	01	02	03	04	05	06	07	M-NC, M-PC	Mar- 07	Mar- 10
Kiyoaki Maruyama	Japan	Genetics/Research Management	M	Board							x	VC-PC	Mar- 07	Mar- 10
					14	10	11	11	12	10	11			



## 6.1.5 Board committees

### 6.1.5.1. Program committee

At WARDA, the whole Board serves as the Program Committee (PC). Since the Board meets only once a year--and meetings of all Board Committees must take place during the same (packed) 3-day period prior to meetings of the full Board--the work of the Program Committee is usually compressed into just a day (or sometimes a day and a half) of intensive presentations by staff, discussions by the committee of the whole, and formulation of recommendations of the PC to the full Board. Based on the Panel's findings and conclusions on research quality (as discussed in other sections of this report), this does not seem to be enough.

The Panel's concerns regarding the limited attention given by the Board's Program Committee to in-depth discussions of the *science* of rice research and science strategy were heightened by our observations of the March 2007 meeting of the PC. At this meeting, most of the time was devoted to discussion of Mid-Term Plans, proposed projects, and research management, rather than scientific issues. The same general pattern seems to have been followed in previous PC meetings as well, as is evident from the minutes of other Board meetings. Our separate discussions with individual Board members at the March 2007 Board meeting reinforced this impression.

The size of the PC could perhaps be reduced in an effort to make its discussions more science-focused, but there would still be only a few "rice-scientists" on the Committee. The recent reduction in Board size has made it harder to satisfy geographic-, CGIAR-, gender-, and disciplinary requirements that still need to be met; and there are fewer vacancies every year that could be used to strengthen the scientific expertise on the Board. Moreover, we believe the pattern of focusing on research management rather than research quality is less a function of the size of the PC *per se* than of its disciplinary mix. In view of these constraints, instead of focusing on the size and composition of the Board and PC, we seek below to strengthen the resources available to the PC for addressing science-related program matters.

The Panel's findings and conclusions on WARDA's research program, particularly the need for greater scientific depth, are discussed elsewhere in this report. However, here we wish to highlight the important role of the Program Committee in determining the Center's research policy and strategy, and in providing effective scientific oversight of program design and implementation. The problem of insufficient time being devoted to scientific issues could be partially addressed by rearranging the agenda of the full Board meeting, and by devoting an additional day or so to discussion of underlying scientific issues and unanswered research questions. If the agenda of the EFC meetings in March, when the full Board is also in session, is suitably adjusted (as suggested below), this time could be made available to the Program Committee.

An alternative would be to have more than one meeting of the Board (and therefore of the PC) every year, as is recommended by CGIAR guidelines and is the practice in most other CGIAR Centers. While this alternative would naturally increase costs, it could be cost-effective, and therefore the preferred option. However, the Panel recognizes that WARDA already has annual meetings of its Board, and six-monthly meetings of the EFC; and in addition, it arranges meetings of its Council of Ministers every two years, and of the National Experts Committee every year. (The latter devotes considerable time to program and partnership-related issues.)

We believe also that adequate strengthening of the program oversight function at WARDA would require more than just additional time being devoted to it. The Panel believes this function could be strengthened by appointing internationally eminent scientists with a good knowledge of rice and/or other cereals to the WARDA Board, thereby increasing the scientific capacity of the Program Committee. However, implementation of this suggestion would take time; would be possible only as vacancies on the Board become available, when the terms of current members come to an end; and would, in any case, be difficult to operationalize, given the special requirements of the size and composition of WARDA's Board, as discussed earlier. Other alternative measures thus need to be found, to immediately strengthen the resources available to the Program Committee for undertaking strategic oversight of scientific research at WARDA on a continuing basis.

Accordingly--and particularly since the Panel hesitates to recommend two meetings of the Board and PC (the Committee of the whole) every year, and until such time that the PC has strengthened its own capacity for effective scientific oversight--*the Panel recommends that the Program Committee augment its resources by relying on an external Board-appointed Scientific Advisory Committee (SAC) comprised of 3-4 outstanding scientists with knowledge of rice and/or other cereals from around the globe, who would provide in-depth guidance on the technical quality and strategic direction of the science undertaken by WARDA.*

These scientists should be selected for their technical rigor and scientific achievements, and would serve as a "standing Panel of peer reviewers on science quality and science strategy". They would provide independent advice to the Program Committee on all science-related issues, thereby enabling the PC (and the Board) to deepen its own discussion of WARDA's research activities, without affecting the size and composition of the Board or the PC. In addition, it is suggested that the documents presented to the PC/Board by Management cover specifically and analytically various options for addressing strategic and scientific questions facing the Center, rather than focusing largely on the details of MTPs and projects, as seems to have been the case in recent years, partially in response to the new (and changing) MTP guidelines introduced for all Centers by the CGIAR Science Council during the past three years.

#### **6.1.5.2. Audit committee**

The Audit Committee (AC), comprised of four members, has been one of the more active Committees of the Board (along with the EFC). It has diligently undertaken the functions assigned to it in the Center's Board manual, and in CGIAR guidelines. The task of the AC has been rather onerous during the period under review, primarily due to the severe dislocation of work and assets suffered by WARDA during the "Ivorian crisis" in 2002-2005, as well as due to the special due-diligence issues brought to the AC's attention by the External and Internal Auditors.

We reviewed minutes of the meetings of the Board Audit committee from 2001 to 2006. The minutes are detailed, and it is clear that pertinent issues are raised and discussed in the meetings. It is evident too that the external auditor freely interacts with the Audit committee and that the committee values their input. The Internal Auditor's proposed work plan and the report on work conducted during the previous year are also tabled by the Internal Audit Head. Concern has been raised in successive audit committee meetings that the internal auditor is unable to complete all the proposed audits included in the audit plan.

The audited financial statements are routinely proposed for adoption by the full Board. It would however appear from a review of AC minutes that the Audit Committee members consistently receive both the management report and the audited financial statement late and just before the meeting (primarily because the Board meeting is in March, just after the accounts have been finalized). It is also noted from the minutes that the Audit Committee does not always get some of the information it requests for from management expeditiously, for example the MTP based reports of expenditure on a monthly basis.

A review of the minutes of Audit committee meetings and management reports for periods between 1999 and 2006 indicates to us that the Center suffered a number of fraudulent losses. For example: a) in 2001 the work of internal audit revealed fraud by a WARDA employee who diverted fuel worth approximately CFA 40 million (the matter is still in court); b) following a request by the Head of Finance, internal audit investigations revealed fraud by a cashier involving about CFA<sup>113</sup> 16.3 million; c) CFA 3.6 million was embezzled from the staff provident fund over a long period of time; d) CFA 10 million imprest was embezzled by a member of staff managing the Guest House in Bouaké during the “Ivorian crisis”; and e) fraud was discovered in 2006, when the administrator of one of the stations was paying himself allowances in excess of his contractual agreement for a period of over 12 months. The matters listed above indicate the necessity for constant vigilance in ensuring the control environment. As a result, IA would be able to quickly detect errors and fraud.

Fortunately for WARDA, members of the Audit Committee have taken their responsibilities seriously, and by all accounts appear to have discharged them effectively. During 2000-2007, key members of the AC have had extensive relevant experience of managing large scientific organizations, and have devoted the time and attention needed to faithfully undertake their fiduciary functions on behalf of the Board. In March 2007, the Audit Committee has been further strengthened by the addition of a professionally qualified CPA with in-depth experience of the CGIAR, and this should help ensure that the AC will continue to function effectively in coming years.

#### **6.1.5.3. Nominating committee**

For appointing members to the WARDA Board, the Nominating Committee (NC) has facilitated the gradual reduction of Board size, the selection of qualified members, and the balancing of competing requirements, as discussed in the section on Board size and composition. By instituting an annual self-assessment program for members, the NC has also helped improve the quality of contributions made by Board members. The Chair and members of the NC have thus served WARDA quite well.

On occasion, however, the planning for orderly succession of Board members has not been smooth or easy. In 2005, the Board faced the possibility of four of its members completing their second terms at the same time (in 2006), with another four members doing so the following year. This situation severely tested the ability of the Nominating Committee to propose strong candidates for Board membership; while at the same time meeting the requirements for common Board membership with IITA, appointment of CGIAR nominees, and gender-, representational-, and disciplinary balance. As a short-term measure, it appropriately tackled this issue by

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<sup>113</sup> 1 Euro = 655.9 CFA since 1994

staggering the expected dates of departure of several members; i.e., by recommending extensions for the affected Board members for periods ranging from 1-3 years.

The NC has also initiated the practice of inviting new members to participate as observers at a Board meeting, prior to becoming full members with Committee responsibilities. This has helped ensure that new Board members have the opportunity to acquire knowledge about the Center and their Board responsibilities before they are called upon to guide Center activities. In addition, the NC has sought to strengthen Board capabilities by nominating members with at least one-year experience on the WARDA Board to the CGIAR-sponsored Board orientation program; and it has led a systematic questionnaire-based process of (self-) assessment of Board members, Board Chair, and Director General. All these steps have succeeded in strengthening Board capacity, and are commended.

In recent years, the NC has also had to respond to some additional requirements as well—such as the appointment of “common” Board members with IITA--and it has done so admirably. The NC has consistently encouraged closer collaboration between WARDA and other CGIAR Centers, and has made special efforts to nominate individuals with extensive experience of the CGIAR system. In the context of the CGIAR-initiated governance alignment with IITA, this has required a balancing of Board composition along several competing dimensions. Based on the Panel’s observations of the NC meeting in March 2007, and discussions with various Board members, the NC seems to have successfully undertaken this delicate balancing act.

The discussions of the NC at the March 2007 meeting were remarkably open and forthright, even during discussion of sensitive issues, such as assessing the performance of the Board Chair and DG, both of which were discussed in the presence of the person being reviewed. At the end of these assessments, the NC sought feedback from the Board Chair and DG on how helpful the assessment process had been for them, and was told that greater confidentiality of discussions could in fact lead to more open sharing of mutual concerns. *The Panel agrees with this conclusion; and strongly encourages the NC to discuss the performance of individuals in a closed session in their absence.* Once the NC has reached a consensus assessment, it should ask the NC--or Board Chair (as appropriate) to provide feedback in a confidential closed session only to the individual concerned.

#### **6.1.5.4. Executive and finance committee**

This Committee is comprised of the Board Chair, Chairs of the three other Board Committees, plus one other Board member (selected at large, with the intention of including one of the common Board members with IITA). The EFC meets in person twice a year, and because the full Board meets only once a year, the EFC has a rather large responsibility throughout the year for overseeing WARDA’s financial, program, human resources, partnership, and other activities.

In general, the EFC has discharged these responsibilities with due diligence and care. The Panel has already noted the substantial contributions of the EFC to the continued well-being of WARDA during the “Ivorian crisis” and its immediate aftermath. Here, it wishes to commend as well the continuing intensive involvement of key EFC members in WARDA business, at Board and Council levels, beyond the normal call of duty for typical CGIAR-Center Board members.

It notes, however, that the March meeting of the EFC overlaps completely with the meeting of the full Board and its other Committees. Besides duplicating many agenda items expected to be

also covered by other Committees around the same time, this gives the impression of a two-tier Board, and also takes valuable time away from a possibly-longer meeting of the Program Committee, as discussed earlier.

At the March 2007 meeting, the Board considered a suggestion from one of its members to suitably curtail the agenda of the EFC to only essential items that it alone could cover in depth (e.g., issues relating to Center finance, human resources, and administration), thereby giving more time to other Committees (such as the PC) to discuss other issues in depth, before bringing their consensus views and recommendations to the full Board for discussion. *The Panel endorses this suggestion to limit the EFC's agenda to essential items that it alone can cover, and expects that this will help further streamline the work of the EFC, as well as of the full Board.*

## **6.2. Management**

### **6.2.1. Management response to the “Ivorian crisis”**

In 2002-04, WARDA was able to weather the “Ivorian crisis” in part due to effective management of the Center by the Director General and his senior management team, with the support of very dedicated staff at all levels, all of whom contributed significantly to keep the Center running under very adverse circumstances. The impact of the crisis, however, in terms of staff capacity for undertaking research and providing corporate services, was far-reaching and long lasting.

The first priority during the civil strife and violence in Cote d’Ivoire was to save lives. On 26 September 2002, as the fighting intensified in and around Bouaké, the DG himself led to safety a convoy of 23 buses and vans with over 250 staff and families. International and regional staff and their families were evacuated to Abidjan; and some scientists were relocated to Bamako (Mali), where ICRISAT had a research station, and to Ibadan (Nigeria), where IITA headquarters is located and WARDA had some ongoing research activities. Some staff, at great personal risk, made extraordinary efforts to recover germplasm, electronic data, financial information, and computer hardware from the M’bé campus. A temporary headquarters, with essential management and administrative staff, was established in Abidjan, and research activities were continued in locations outside Cote d’Ivoire, primarily in Senegal and Mali.

By early 2003, the Center had signed a host agreement with the Government of Mali, with the expectation that Bamako would provide a temporary home base for WARDA until the situation improved sufficiently in Cote d’Ivoire. In late 2004, the Management decided to move back to Bouaké; but information regarding this decision was not given to the Mali government in a timely manner. The aborted return to Bouaké in November 2004 meant that the Center was forced to relocate once more. Based on a study of options available to the Center, the Board decided to temporarily re-locate the Center to Benin. In January 2005, the IITA research station in Cotonou became WARDA’s temporary headquarters, following a new hosting agreement with the Government of Benin, and a tenancy agreement with IITA.

Understandably, the impact on the management of the Center was considerable. Essential staff members were relocated to rented offices in Abidjan at great cost; some staff were laid off; staff lost property and belongings at M’bé and Bouaké; and more than 80 vehicles were stolen by the rebel forces. There was high staff turnover, both among the IRS and the regionally- and locally-recruited GSS (general services staff). In addition, because of uncertainties of returning to WARDA headquarters, recruitment of quality staff became more difficult. The families of many

staff were unwilling to return from their home countries, primarily due to the trauma suffered during the evacuations from Bouaké, concerns regarding workplace- and job security, and the difficulty of finding good schools in remote locations.

Despite this, WARDA's activities were never closed down, even at the height of the 2002 and 2004 crisis. In the midst of the evacuation, relocation, and resettling, WARDA developed a new Strategic Plan 2003-2012, restructured its overall organization into two major divisions, Research & Development and Corporate Services, and prepared a new Medium Term Plan with two R&D Programs and eight consolidated MTP projects. It also moved into East and Central Africa and established a new "station" in Tanzania, and continued to develop and disseminate new NERICA varieties. Full credit must go to WARDA Management, staff and families for their tenacity, dedication, and hard work throughout this very stressful period.

In terms of the impact on WARDA's finances, Management estimates the total cost of evacuation and relocation of staff from Bamako to Cotonou (i.e., excluding the cost of relocation in 2002-03 from Bouaké to Abidjan and Bamako, during the height of the "Ivorian crisis", for which an estimate is not available) at about US\$3.9 million. This includes: evacuation of staff in November 2004 from Cote d'Ivoire to Bamako or to their respective countries; relocation of staff from Bamako to Cotonou in January-February 2005; shipment of personal effects, scientific equipment, and office furniture from Cote d'Ivoire and Mali to Cotonou; conversion of two IITA greenhouses to offices; and the cost of laying off approximately 65 GSS, paying their terminal benefits, closing the Bamako station, and retaining a skeletal staff specifically to maintain WARDA facilities in Cote d'Ivoire. To help defray these expenses, in 2002-2003 WARDA received US\$2.4 million special support from donors (including the World Bank, Japan, DFID), leaving a net cost exceeding US\$1.5 million.

#### **6.2.2. Rebuilding management capacity**

Recognizing the severe toll the "Ivorian crisis" and the trauma experienced in Bouaké had taken on staff, a number of "Team Building" surveys, interviews, and workshops were conducted by consultants in March-July 2004 when WARDA was temporarily working from Bamako. These addressed such topics as organization and structure, communication and management of information, exercise of power and leadership, and client and supplier relationships. The consultants uncovered a variety of issues related to the organization and structuring of human resources, management style and authority, staff accountability, motivation, communication, trust, research monitoring, etc. They recommended corrective actions across the board, in all these areas.

In response, Management indicated a willingness to undertake many of the actions suggested, including the introduction of improved administrative and human resource systems, procedures, and processes; strengthening the role of the HR Officer; and restructuring the Corporate Services division. Follow-up action was taken in some areas, but was soon overtaken by other events, primarily relating to the planning and preparation for a return of WARDA to Bouaké. This return was attempted in October-November 2004, but had to be tragically aborted, as noted earlier. This naturally was a huge set back to Management and staff, in terms of their capacity to manage and undertake productive research and to provide the administrative services needed to keep the Center running efficiently.

Upon relocating to Cotonou in January 2005, attempts were again made to overcome the damage caused by the turmoil of the previous two years. In April 2005, WARDA Management provided all staff the opportunity for individual and group counseling, and this apparently helped substantially to heal the psychological wounds, though some scars inevitably remained. New managers and staff were hired to replace those who left the Center for various personal or professional reasons, or to fill new positions required for implementing the new MTP. Almost half of the IRS, and most of the GSS, now working for WARDA in Cotonou were hired after the Center established its temporary headquarters at the IITA (Benin) station. Some of these new recruits took time to learn how to work effectively with “veterans” of the “Ivorian crisis”, led by the Director General and his inner circle of confidants, who had forged strong bonds amongst themselves.

Some staff apparently also needed extra time and mentoring to meet the high standards expected of professional staff and managerial systems at international Centers. This was not always easy to do, as was noted, for example, by the CGIAR Internal Audit Unit’s (IAU) review in September 2005 of the Finance department. This review, undertaken by a consultant, examined in depth the Finance department’s organization and processes, and noted deficiencies in several areas. It highlighted the need for streamlining processes to improve efficiency, help meet month-end deadlines, and relieve staff workload; reviewing allocation of duties to staff, and assessing senior accountants and their capabilities; improving management reporting, by providing more timely and better information on costs of personnel and overhead, and ensuring that reports are accurate; ensuring better leadership within the department, and a more assertive role outside it; and improving internal controls through appropriate separation of duties among staff.

This review’s recommendations are currently being implemented. However, additional measures are still needed, as discussed below in the section on Financial Management. The Center has also followed-up on the Team Building exercise undertaken in 2004. At a 2-day off-campus retreat in February 2006, the entire Senior Management Team plus project leaders undertook a fresh assessment of selected aspects WARDA’s program and administration, explored ways of improving staff performance, discussed steps needed to implement decisions taken by the CGIAR at AGM05, and proposed a way forward. The report of this self-assessment by senior WARDA staff was presented to the Board at its March 2006 meeting in a commendably transparent and forthright manner.

Included in the report were issues and solutions identified by staff (before discussion with Management). These related to:

- *Human resource management*: a) staff morale not optimal, lack of orientation of new staff, no clear policy on staff development; b) workload, lack of support staff, crisis relating to space, lack of staffing plan; and c) inadequate communication and team building, lack of horizontal communication, unclear lines of communication;
- *Publishing*: lack of team approach to publications, poor research and documentation/data recording and management, no obvious sanctions;
- *Resource mobilization*: lack of institute-wide strategy, weak project proposals, inexperience in resource mobilization, poor knowledge of donor requirements, no incentive for resource mobilization, lack of personal responsibility, low institutional budget for publications;
- *Finance and budget*: low or delayed annual budgetary allocations for research, deficiencies in reporting expenditures incurred in research, cash flow problems due to delays in receiving donor contributions, and insufficient client-orientation among staff of the finance department;

- *Support services*: delays, time taken in vehicle repairs, restrictions in hiring staff or obtaining computer resources;
- *Institutional image*: low participation at international meetings, poor international media strategy, WARDA still perceived as a West African Center, external perception that there were extended vacancies, massive staff turnover, and instability;
- *Programmatic challenges*: poor documentation of post-impact of NERICA, poor availability of seeds, what next after NERICA? and
- *From AGM decisions to action*: no solution in Cote d'Ivoire in the foreseeable future (3-5 years), temporary base at the IITA campus makes WARDA vulnerable for merger, problems of the lengthy dislocation from its permanent headquarters.

The Management Retreat had obviously brought to the surface a number of problems that were perceived by staff as having accumulated over the years. To their credit, senior managers of WARDA acknowledged some of these pending concerns, and proposed corrective actions for each set of issues. They resolved to: maintain focus on their vision of WARDA, and to share it with all staff; broaden and strengthen the ownership base among staff; keep everyone on board and improve staff morale; enforce rules, norms, and procedures related to staff performance; design and implement rewards and sanctions; and respond proactively to the changing policy environment within the CGIAR, and at the level of the African Union/NEPAD. Immediate action was initiated by the Director General and his Senior Management Team (SMT) on a number of issues; and was ongoing when the DG completed his second term in November 2006.

### **6.2.3. A new beginning**

In October 2006, the new Director General of WARDA—who had been on the Center's Board since 2004—presented to staff his “new vision” for the Center. In a presentation titled *Reorganizing WARDA to Enhance its Competitiveness*, he asked staff to “start doing business in a new and better way by changing attitudes and behavior in order to transform WARDA”. His list of what needed to be done built on the assessment undertaken and proposals initiated by the outgoing DG and the SMT that the incoming DG inherited. Understandably, it also included additional aspects, and formulated a novel approach to initiate a new way forward.

The list included the following items: ensure that the vision is shared with all staff; in research, avoid bureaucracy, encourage team spirit and solidarity, improve management of resources; improve credibility, quality, and impact of research; improve research documentation and proposals; be open to partnerships; and serve NARS, in order to have significant impact. The overall goal was to urgently make WARDA more competitive, diversified, sustainable, and a powerful tool for the development of Africa's rice sector. For this, the DG sought to develop a “new” breed of scientists who could bring in funds, do high quality research, communicate effectively, and provide knowledge and technologies to their partners. For the staff, in general, he wished to provide better working conditions, adequate equipment, research assistants, administrative support staff, fair evaluation of performance, and proper incentives. The DG also proposed specific actions for implementing his new vision, and presented these to the Board in March 2007 for information and comments.

These actions are consistent with the diagnosis and results of the very useful WARDA Risk Management Workshop facilitated by the IAU in October 2006. The recommendation was to reconstitute a risk management team to meet quarterly. The SMT identified the following as the 5 top risks facing the Center: loss of, and lack of access to, research data; centralized



governance/management style of the DG and senior managers, slow decision making because of too many committees without authority, and lack of transparency in decisions made; changing donor priorities, and difficulty of attracting restricted funding; weak internal controls during implementation, hence policies not translated into practice; and commitment of WARDA member States, in relation to rice policy, merger with IITA, contributions to WARDA, and credibility with other donors.

Workshop participants translated these five risks into four key messages for WARDA, as follows: Improve internal housekeeping/management practices, and put emphasis on resource mobilization and people management; strengthen communication, both internal and external; strengthen research management, particularly in relation to research data; and enhance the public awareness drive, particularly in relation to key stakeholders such as member States. They then listed a number of actions that could be taken to mitigate each risk and to address its symptoms and underlying causes. These proposed actions were presented to the Management and Board, and were endorsed.

Further work needs to be done for the assessment and identification of risks to trickle down to the level of Units. There also appears to be uncertainty over whose responsibility it will be to ensure that the Center manages its risk adequately. The February 2007 report suggests that the Center reconstitute the risk management committee with appropriate technical people from research and corporate service. *The Panel endorses the proposed reconstitution of the Risk Management Committee; and urges the Board and Management to take steps to ensure that the risk management process within WARDA is internalized and appropriately monitored and managed.*

The Panel believes the approach taken by the new DG and his senior managers thus far is sound, and needs to be encouraged. The actions proposed in the Risk Management workshop report of 19 February 2007 will help WARDA manage many of the key risks it presently faces. In addition, recognizing that the Director General plans to address a number of other pending issues, and to lead WARDA towards a worthwhile though ambitious goal, in general, the Panel supports the DG's new vision and proposed actions (see Box 6.2.1 below). While we do not consider it necessary or appropriate to comment in detail on every aspect of this list of planned actions, we offer below (and in other sections of this report) comments on a few selected aspects of organization and management that could have longer-term strategic importance for WARDA.

**Box 6.2.1 Specific Actions Proposed by the Director General in October 2006 for Implementing his New Vision for WARDA**

**For the Research & Development Division:**

- Ensure a strong research Directorate capable of taking right decisions at the right time
- Review the design of projects to have critical mass and establish thematic groups
- Recruit a biometrician (part time)
- Simplify scientific structure: put projects under two Programs, under a ADG-R; plus have Thematic groups (breeders, agronomists, economists etc); current Asst Directors will become new Program Leaders for one year; then the next Program leaders will be selected by the scientists of respective Programs, based on specific criteria

- Scientists, including Program Leaders, will spend about 80% of time on research, 20% on administration
- Scientists will produce 2 peer-reviewed publications per year
- Scientists will submit 2-3 bankable projects per year
- A communication and marketing unit will be established to provide donor information to scientists, provide necessary support to scientists to develop and finalize concept notes and project proposals, be part of a committee to evaluate concept notes, support the DG in all communication work, and raise public awareness of WARDA's research
- Research Director to propose the way forward for work on post-harvest technologies
- Research Director to propose a strong capacity building strategy for NARS
- Research Director to plan and organize scientific seminar series (invite researchers from within and outside WARDA), document recommendations from discussion, and share the information on Research Days.

**For the Corporate Services Division:**

- Interact more closely with scientists and provide regular assistance, always remembering that WARDA is a research Center
- Strictly follow the Manual of Procedures, which should be posted on the intranet and should be applicable to all staff, including the DG
- Develop quarterly plans for WARDA cash flow (note that budget is not cash flow)
- Provide monthly budget reports (with analysis of the gap between approved budget and its implementation)
- From 1 Jan 2007, the current system for travel advance will be changed to per diem
- Decentralized management: One GSS representative will attend EMC as observer, designated by GSS; one GSS will attend AGM by rotation; one will attend SMT
- Develop a training plan for all staff members (to improve their competitiveness)
- Staff members should provide copy of their last degree/diploma to HRO for staff files
- Computerization of routine office procedures and forms
- Rationalize consultancies (hire consultant only when competencies not available in house or staff are too busy)
- Regularize and monitor personal accounts
- Set up a suggestion box for staff to give ideas for improving Center's efficiency (not to be misused for personal attacks)
- Strengthen internal auditing (all staff will be equally treated, including the DG).

#### **6.2.4. Financial management**

##### **6.2.4.1. Funding and performance indicators**

The trend in the quantum and composition of grant income for WARDA, and the key performance indicators related to its annual operations and financial position, are highlighted in the Table 6.2 below. The Panel notes that the financial situation is stable, and the performance indicators for short- and long-term solvency are within or better than the range recommended in the CGIAR Financial Guidelines. The indirect/direct cost ratio is somewhat higher than the recommended 20%, but has improved during the past few years, as discussed further below.

<b>Table 6.2 WARDA's Funding and Performance Indicators — 1999-2006</b>								
	<b>2006</b>	<b>2005</b>	<b>2004</b>	<b>2003</b>	<b>2002</b>	<b>2001</b>	<b>2000</b>	<b>1999</b>
<b>GRANT INCOME</b>								
Unrestricted*	5.924	5.831	5.804	4.756	4.427	4.272	4.679	6.512
Temporarily restricted	5.035	5.191	4.221	4.411	5.158	4.798	3.407	2.558
<b>Total</b>	<b>10.959</b>	<b>11.022</b>	<b>10.025</b>	<b>9.167</b>	<b>9.585</b>	<b>9.070</b>	<b>8.086</b>	<b>9.070</b>
<b>PERFORMANCE INDICATORS</b>								
Operating surplus (Amounts in US\$'000)	281.8	779.1	823.9	854.4	449.7	149.3		
Working capital (Amounts in US\$'000)	2,864	2,356	1,520	584	(85)	(798)		
Short term solvency** (liquidity)- Days	102	87	59	22	(10)	(30)		
Long term financial Stability** (Adequacy of reserves)- Days	102	87	59	22	(10)	(30)		
Indirect/direct cost ratio**	27.9	43.7	48.6	-	-	-	27	-
<b>**CGIAR recommended levels for Financial ratios:</b>								
Short term solvency: 90 to 120 days								
Long term financial stability: 75 – 90 days								
Indirect/direct cost ratio: 20%								
*Note: The World Bank gave WARDA a special grant of US\$180,087 in 2002, US\$1,221,243 in 2003, and US\$430,000 in 2004 for extraordinary expenses incurred because of the crisis in Cote d'Ivoire. These amounts are not included in the annual grant income analyzed here for the period 1999 to 2006.								

#### 6.2.4.2. Resource mobilization

Total grant income has not increased significantly on an annual basis since 2000 (see Table 6.3 below and Annex XIII). The contributions to WARDA in 2006 are below. There has been a noticeable change in the composition of funding, with a gradual increase in the restricted portion of grant income over the years: restricted grants constituted 46% of funding in 2006, compared to only 28.2% in 1999. The decline in the proportion of unrestricted grants has limited Management's freedom to utilize WARDA's income for some priority areas and for covering overheads, but is the result of increasing competition for such funds and the preference of some donors to earmark/restrict funds for specific projects or budget lines. Since this trend is common to all CGIAR Centers, and seems difficult to reverse, it implies the need for strengthening the Center's capacity to produce project proposals that attract funding.

<b>Table 6.3 WARDA's Grant Income for 2006 (US Dollars)</b>			
<b>Contributors</b>	<b>Unrestricted</b>	<b>Restricted</b>	<b>Total</b>
Japan	737,965	942,673	1,680,638
World Bank	1,086,000	286,702	1,372,702
The Netherlands	867,000	469,190	1,336,190
Canada	505,214	771,542	1,276,756
United States of America	200,000	739,520	939,520
United Kingdom	914,800		914,800
AfDB		707,362	707,362
Norway	654,688		654,688
Sweden	426,279		426,279
Rockefeller Foundation		376,477	376,477
Germany	192,132	93,641	285,773
United Nations Programs		272,610	272,610
Belgium	245,271		245,271
IFAD		224,211	224,211
France	95,645		95,645
European Union		86,510	86,510
Other Small Donors		50,515	50,515
Taiwan		13,630	13,630
<b>Total Restricted Grants</b>	<b>5,924,993</b>	<b>5,034,582</b>	<b>10,959,575</b>
<b>Other Revenues:</b>			
Member State Contributions			113,597
Center Earned Income			363,300
<b>Total Grant and Other Revenues</b>			<b>11,436,472</b>

WARDA has made progress in this direction, and has been able to recoup more of its direct costs from restricted projects. This effort is expected to be intensified in coming years, in line with the new DG's vision for WARDA that includes a concerted drive on fundraising and recovery of full direct costs of project. It is intended to create a special Communications and Marketing Unit for this purpose. The DG has been able to obtain tangible evidence of a "re-commitment" to WARDA by Member States during his courtesy visits to these countries following his appointment in December 2006. As a result, the arrears on member contributions have been reduced considerably in several cases (see Table 6.4. below).

The annual contribution rates of member states have remained the same over many years; and receipts from January 2000 to December 2006 have totaled approximately US\$ 804,823. Over a period of 16 years, from 1990 to 2006, WARDA collected a total sum of US\$ 4.2 million or an annual average of US\$ 263,000. In 2007 alone WARDA expects to collect a total of US\$ 2.48 million, which is equivalent to the average contributions for 9.5 years. Nigeria's arrears of US\$1.2 million, which were the largest, have now been cleared. In 2007, four countries have contributed for the very first time: Guinea Bissau, Liberia, Niger, and Guinea. These new funds, collected in 2007, will be recognized in 2008. Based on this progress and assurances from other Member States, there is some reason to be optimistic regarding these Member countries' continued financial support for WARDA.

<b>Table 6.4 Member States Contributions (and Arrears) to WARDA</b>			
	<b>Annual Contribution</b>	<b>Arrears at 31 Dec 2006</b>	<b>Arrears at 11 July 2007</b>
Benin	27,764	52,961	0
Burkina Faso	18,283	248,453	266,736
Cameroon	27,742	324,485	352,227
Côte d'Ivoire	42,324	186,010	0
Guinea	18,283	408,406	426,689
Guinea Bissau	18,283	408,406	376,688
Ghana	37,202	567,443	604,645
Liberia	18,283	378,405	378,557
Mauritania	18,283	408,406	426,689
Mali	18,283	54,849	73,132
Nigeria	160,175	1,056,648	0
Niger	18,283	426,689	426,689
Senegal	18,283	18,283	17,030
Sierra Leone	18,283	363,791	382,074
Chad	18,283	408,406	426,689
Togo	18,283	367,604	385,887
Gambia	18,283	381,153	399,436
	<b>500,000</b>	<b>6,042,113</b>	<b>4,943,168</b>

WARDA recognizes member states' contributions as revenue in the year following that in which they are received. The accounting treatment on receipt of contributions is to debit cash as an asset and to credit a payable account as funds received in advance. The balance sheet does not therefore reflect the correct position as the funds received are not "paid in advance" by member states but are payments for arrears. If the member states were making pledges for the arrears, one would understand the reservation against accruing the pledged amounts. In the light of the significant increase in collection of arrears from member states in the first three months of 2007, the Panel was informed that WARDA management has made a special request to the Board to allow the Center to recognize contributions received in 2007 as income for 2007, and to revert to the earlier policy for future years. However, during its visit in July, the Panel was informed that this was no longer needed. The current accounting policy on recognition of member states' contributions makes comparability of annual accounts from year to year somewhat difficult. To avoid this problem, *the Panel suggests that the accounting policy for Member States contributions be permanently changed so that these contributions are recognized in the year in which they are received.*

#### 6.2.4.3. Indirect cost ratio

The indirect cost ratio is a measure of how much research activity a Center is able to support on its institutional cost base. WARDA's indirect cost ratio for 1999 was 27. This ratio was computed during the pilot studies undertaken for all CGIAR Centers, and was based on WARDA's financial data for that year. WARDA did not thereafter compute its indirect cost ratio for 2000, 2001, 2002 and 2003 and the Panel was informed that disclosure of the rate was not mandatory for CGIAR Centers until 2004. In the Panel's discussions with the Center's external auditors, they indicated that they do not express an opinion on the rate computed.

WARDA's indirect cost ratio has significantly decreased between 2005 and 2006 (see Table 6.2 above). Management has indicated that the high indirect cost ratio in 2004 and 2005 was due to the extraordinary support activities during the crisis, and a different allocation of some "common sustenance services" to operations. A correct method of computation is now in place.

In the Panel's view, the earlier higher ratio may also have arisen from lack of clarity in coding of expenses, and the reclassification and reallocation of expenditure traditionally undertaken by the Finance department towards the year-ends, a concern raised by WARDA's auditors during the same period. The Center therefore needs to tighten its control environment to ensure integrity of the accounting system and procedures, and needs to reduce the possibility of arbitrary reallocation and reclassification of expenditure between account codes at year-end. In addition, a further decline in the indirect cost ratio can be achieved by a stronger effort to ensure that all service/cost Centers systematically charge full costs to the projects that receive such services.

#### **6.2.4.4. Control environment**

As noted above, the accounting and internal controls had deteriorated during the "Ivorian crisis". Two Senior Accountants and three Accounting Assistants left in 2005, and individuals with less experience and qualifications replaced the assistants. This put considerable pressure on the only Senior Accountant who remained, and on the Head of Finance. As a result, the audit of the financial statements for 2005 was strenuous, and was delayed. Two Senior Accountants were recruited in 2006 to complete the staff complement in the department, but they require continuous training and exposure to non-routine tasks.

The unexpected reduction in staff of the Finance department led to an inadequate segregation of duties, and precluded an acceptable level of oversight over financial transactions. At the March 2006 Board meeting, WARDA's external auditors expressed their concerns, indicating that the deterioration in the control environment was a combination of: a) weakening of internal control following successive relocations; b) non-satisfactory application of procedures (bank reconciliations); c) insufficiency of the means of implementation (understaffing leading to assumption of incompatible tasks); and d) limitation of the mandate of the internal audit service.

The Panel's review indicates that, as noted by the external auditors, the control environment needs to be continuously monitored. Random spot checks of accounts, as well as in-depth internal audits of financial procedures and how well they are followed in practice, are needed. Such monitoring could cover a variety of financial management areas, including the management of employee accounts and personal loans, local imprest accounts, ledger accounts, internal audit files etc; and also seek to reduce delays in reporting to budget holders. In addition, *the Panel recommends that the Financial Procedures Manual (which was last issued in 2001) be updated and suitably revised, as needed; and that compliance with these procedures be ensured by the Board and Management so that the financial control environment operates as intended.*

WARDA Management is in the process of addressing these concerns. However, knowledge of preparation of financial statements and reports in WARDA rests in the Head of Finance, who has been at the helm of WARDA finances since 1989. It would be extremely difficult for any of the staff currently in the finance department to prepare management accounts and financial statements in his absence. Since the beginning of 2006, the Head of Finance has been on short-

term employment contracts of 2-3 months at a time, and then six months to December 2006. He is currently on a one-year contract to the end of 2007, but this is being reviewed.

None of the staff in the finance department are well versed in the SUN Accounting system software, with the exception of the Information Systems Administrator–Finance, whose responsibility it is to prepare programs and also to run the management and financial reports. A report on the review of the Finance Department organization and processes conducted in 2005 by the CGIAR Internal Audit Unit (IAU) in conjunction with WARDA Internal Audit Section recommended that one or more staff members within WARDA's Finance and IT groups be trained to undertake these tasks to ensure sufficient back-up capacity.

The lack of sufficiently trained and experienced staff poses significant business-continuity risks to WARDA's financial operations. It is an unnecessary risk to employ a head of finance for short periods at a time. To reduce these risks, Management must ensure the employment of appropriately experienced and competent managers and accountants in the Finance Department, and provide them stability of tenure. *The Panel urges Management to review the performance and tenure of the Head of Finance and take suitable action regarding his contract terms; and that appropriate delegation of responsibility from the Head of Finance to suitably qualified and trained Senior Accountants be ensured.*

#### **6.2.4.5. Budgetary control**

Following the "Ivorian crisis", the Head of Finance performed the role of Budget and Planning manager. During the period covered by this review, the external auditors have expressed reservations about budgetary control within WARDA. Their concerns relate to: a) reallocation of expenditure to budget codes without the agreement of budget holders at year end; b) non-validation by the budget holder of management reports transmitted to donors; c) pre-financing of projects before obtaining grants from donors; and d) no efficient mechanism to anticipate budgetary over-expenditure on projects, thereby increasing the risk of non-recovery of such expenditure related to restricted projects. In addition, budget holders have complained that they did not receive timely reports on project expenditures, except in 2006 when more information has been provided periodically.

Efforts have been made by Corporate Services to address these shortfalls. Budgetary control has improved following the appointment of a full-time Planning and Budget Manager in 2006. Monthly reports of expenditures are now sent to each budget holder. Previously, there was no requirement for the latter to certify the correctness of the report, and considerable follow-up was needed by Management and the Planning and Budget Manager to obtain this confirmation. This deficiency has been rectified. However, scientists are presently unable to view on-line the accounting entries on their projects; and there is delay in uploading budgetary figures onto the accounting system.

There is thus further scope for enhancing budgetary control, fostering accountability of budget holders, and ensuring that financial management meets expected standards. For this, there is a need to clearly delineate the tasks and responsibilities of the Budget and Planning Manager, so as to avoid overlap and inconsistency in budget-related responsibilities that are still being undertaken by the Finance Manager (such as reporting to donors on financial aspects of projects, and clearing payment requests by project-budget holders against their approved budgets). Accordingly, *the Panel suggests a review of the responsibilities of the Finance Manager in*

*relation to budgetary control, to remove any overlap with tasks that should be performed by the Planning and Budget Manager; and that the latter be appointed to relevant Center Committees dealing with planning and budgeting matters*

#### **6.2.4.6. Internal audit**

From 2001 to 2005, solely the Internal Audit Head staffed the Internal Audit department; and an assistant was recruited in September 2005. Internal Audit prepares annual plans, which are approved by the Board's Audit Committee (AC) annually. However, the internal auditor has not been able to undertake all the audits planned for each year. This is attributed to the shortage of staff in the department; and to the addition of other ad hoc audits and investigations that have to be done each year.

The AC approved the charter of the internal audit unit in 2005. While the mandate is wide and all embracing, and is in line with international best practice, the Panel notes that the work undertaken by the Internal Auditor has not covered procedural review of key internal controls over areas susceptible to high risk. Processing controls and the integrity of the financial management system for WARDA have rarely been prioritized for audit. The work undertaken tends to emphasize investigations of possible malpractice or error, or areas that the DG and Management request to be investigated.

The internal auditor's work should encompass review of the Center's internal control environment, including systems and processes. The audit plan should also be discussed with the external auditor to ensure that they can rely on the work of the internal audit. This could lead to a reduction in time spent by the external auditor on the annual audit, and possibly a reduction of fees. The involvement of the WARDA Internal Auditor in audits of other Centers undertaken by the CGIAR Internal Audit Unit is a welcome development, for it will increase the exposure and capacity of the Internal Auditor.

The Audit Committee has noted delays in completing audit assignments (particularly the audit report on project costing, which was commenced in 2004). There is no formal requirement that the units audited formally respond to the report of the internal auditor, and in some instances, it has taken the intervention of the DG to obtain responses from auditees. This deficiency needs to be corrected by Management assuring the independence of the internal auditor, and ensuring that staff recognize the importance of the internal audit function.

#### **6.2.3.7. External audit**

The external auditor appointed by WARDA since 2002 has issued unqualified audit opinions annually. The latest financial statements issued by the auditors are for the year ended 31 December 2006. The external auditors perceive that the control environment within WARDA is currently moving towards an acceptable level, after having deteriorated significantly during the "Ivorian crisis". The loss of staff, resulting in the remaining staff undertaking incompatible tasks during the crisis period, led to a degradation of accounting and internal controls. Inadequate day-to-day monitoring of activities of junior accounts staff was cited as one of the key weaknesses in financial management at WARDA, but this area is now receiving attention.

The external auditors have issued a management report in each of the years covered by this review. Some issues that have been raised consistently include: a) weak control environment,



particularly during crisis years 2002–2005; b) inadequate budgetary system, resulting in cumbersome budget monitoring, inappropriate expenditure coding, and budget overruns of various expenditure lines; c) reclassification of expenditure from one budget code to another without the budget holder's agreement; d) inadequate management of exposure to foreign exchange risk; and e) inadequate analysis of employee advances accounts.

They also reiterate the need to have budget holders confirm the accuracy of financial reports issued by the Finance Department, as opposed to the current situation where they are merely required to indicate receipt of the reports. They, however, believe that the financial management information system run on SUN is adequate for WARDA's needs.

A Board resolution has called for bids for external audit services for the year ending 31 December 2007, and IITA and WARDA are considering the engagement of the same firm of auditors, in line with the Agreement to align corporate services. The selection of a suitable firm should now be expedited, so that the auditors could undertake an interim audit prior to year-end, if needed.

#### **6.2.4.8. Financial problems of the Inland Valley Consortium**

In response to the SC issue on the Inland Valley Consortium (IVC), the Panel's comments on financial management of the IVC are given below. A CCER on the IVC (Phase II) was conducted in 2004, and a report issued in October that year. It notes that information on the expenses of IVC were not available from the WARDA Finance Department during the CCER Panel's visit. The National Coordinating Units (NCUs) have complained of delays in receiving funds allocated for their national activities from the RCU. From about 2003, France and the Netherlands, IVC's two traditional donors (providing over 60% of IVC funding from 2000 to 2005) ceased to specify their financial contribution directly to IVC activities. They preferred to support the core budget of WARDA and left it to WARDA to reallocate the funds within its program and projects.

Management has indicated that problems during the "Ivorian crisis" prevented the Finance Department from releasing budgets and funds to NCUs on time and that the NCUs were not satisfied with the level of transparency in the allocation of resources to IVC and in turn to the NCUs. However, according to WARDA Management, it has now taken appropriate action for timely information to be passed to the IVC Regional Coordination Unit (RCU) about the money spent and the available budget. At their meeting in November 2006, the CSC received a transparent overview of the current year, the previous year, and a forecast of the following year's budget. The presentation made by the ADG-CS and Budget officer was apparently appreciated by the CSC, which reportedly confirmed that the situation had improved.

Discussions with Management also reveal that from 2007, the DGIS (The Netherlands) has stopped funding single-commodity Centers such as WARDA, and France has scaled down its funding to WARDA from \$190,000 in 2002 to \$75,000 in 2006. Currently other sources of funding for IVC include special projects with specified end-dates. Clearly, the loss of DGIS funding and scaling down of France's contribution puts the sustainability of the IVC program at risk. At the same time, a larger proportion of core funds may have to be used to shore up the IVC activities/projects, thereby increasing the likelihood that relevant core expenditures would need to be scaled down. However, WARDA's external auditors and the Internal Audit unit did not have much knowledge of IVC, which could mean that IVC is not considered a large and

prominent project requiring special attention, but is instead treated as a series of projects within WARDA accounts.

To help overcome these problems, *the Panel urges WARDA to better involve NCU's in the preparation and adoption of the IVC budget.* For improving transparency, there is need for an agreed rationale for allocating resources to partners in member states. Aggregate financial information needs to be collected for IVC, and then reported by country and (sub) project; and this information could be regularly provided to Management and NCUs. In addition, accountability of funds disbursed to NCUs could be enhanced by requiring the retirement of funds advanced by the Center on a periodic (perhaps quarterly) basis. Such an approach, emphasizing financial transparency and accountability, has general applicability for other WARDA partnerships as well.

### **6.3. Corporate services**

The decentralized management of the Center and of the Corporate Services Division, as well as closer interactions between administrative staff and scientists, and consistent and transparent use of management systems, procedure manuals, and decision process are necessary; as has repeatedly been noted by WARDA managers and staff themselves during the past few years. The Panel therefore supports the various actions planned to be taken by the DG, ADG (CS), and managers of various service units to further improve the “service orientation” and administrative efficiency of corporate services at WARDA.

We note that many of the current needs for improvement--as pointed out in various staff Retreats and Workshops, and briefly summarized above--relate to a various aspects of general administration, finance, budgeting, and human resource management. For addressing some of these, it may not be enough to simply follow current procedures or to tighten the enforcement of existing rules and regulations. Instead, a more thorough review of systems, policies, and processes would probably be needed, so that the “bar could be raised” for the delivery of corporate services, just as it is being raised for the research program at WARDA.

The need for improving the level of services provided has been highlighted by the staff perceptions survey conducted by the Panel for this review (see Annex XIV). A total of 69 staff responded to this survey, including 31 (70%) of the 44 IRS and 38 (23%) of the 164 GSS who received the survey instrument electronically. Over 90% of these respondents said that WARDA's “new vision” is shared by staff. Nevertheless, many respondents expressed dissatisfaction with the level of purchasing/administrative services provided to them. In the human resources management area, staff expressed dissatisfaction with regard to WARDA as an attractive place of work, performance management, professional advancement, training, and compensation; with GSS more dissatisfied than IRS, in general. Staff are also concerned about the proposed alignment of corporate services with IITA, and would like their views to be taken into consideration by Management.

The recent recruitment of an experienced ADG (CS) and an Human Resources Manager augers well for strengthening these functions; as do the efforts already underway in other corporate services units to implement the actions agreed upon during the various workshops, retreats, and reviews undertaken at WARDA in 2004-07, some with the assistance of external consultants or staff of the Internal Audit Unit of the CGIAR. The Panel's comments on some of these aspects are given below.

#### **6.4. Changes in Staff Profile**

The “Ivorian crisis” had a major impact on the human resources available to WARDA. The number of IRS fell from 59 in 2001 to 42 in 2002; and both departures and recruitment were affected. A total of 35 IRS have left WARDA since 2002, and 63 have been recruited. As a result, more than 60% of current IRS staff has been at the Center for less than 3 years. The turnover in scientific staff--such as breeders, agronomists, physiologists, economists, and technology developers--has been significant.

Some of the departures were, however, reportedly the result of differences of opinion and management style between the DG and some of his senior managers. In July 2002, for example, the Deputy Director for Research left after serving WARDA with distinction for over a decade; and in March 2003, the Director of Research left after serving WARDA for only eighteen months. The ADG (Research) who replaced him, left after two years. It thus appears to the Panel that this instability in staffing scientist positions could not have helped WARDA maintain its cutting-edge science, as noted elsewhere in this report.

The changes in leadership and capacity in the Corporate Services division have been no less frequent and significant. For example, the Director of Administration and Finance left in January 2004, after a stay of only two-and-a-half years, when WARDA was still being administered from its temporary location in Bamako. He was followed by an interim Director, appointed for 6 months, before an ADG (CS) took over in July 2004; and this incumbent too left within two years, in March 2006, when the current ADG (CS) was appointed. Since 2001, the average tenure for the Head of Corporate Services has been less than 18 months.

In addition, the Assistant Director for board and donor relations, and the Head of Human Resources left WARDA in 2005. A senior GSS staff member, on an interim basis, replaced the latter for almost two years, until the current HR Manager was appointed in March 2007. The Planning and Budget manager was appointed in 2006 (though he has considerable prior experience in IITA); and the current head of Finance is serving in a Consultant capacity since 2005 (though he has been at WARDA since 1998, and was the Finance Manager for 7 years, until 2005). These frequent changes in key administrative positions have inevitably meant that the Corporate Services division of WARDA will need to be further strengthened in coming years.

In terms of geographic diversity, however, WARDA has done very well. In 2005, it was the most diverse CGIAR Center in terms of nationality of its IRS. Over the 10-year period 1995-2005, more than 27 different nationalities have been employed at WARDA at the IRS level. These include three countries in N. America, 15 countries in Sub-Saharan Africa, 7 countries in Europe, and 2 countries in Asia. There has also been a remarkable shift from North to South: the ratio of IRS scientists from the South increased from 44% in 1995 to 73% in 2005, and was 80% in 2007. There has been progress in terms of gender balance as well--there was only one female IRS in 1996, but in 2005, there were eight female IRS, and presently there are six female IRS. In addition, a spouse employment scheme has been implemented since 1996; and in 2005, there were four “IRS spouses” working at WARDA. All these are commendable achievements.

#### **6.5. Alignment of corporate services with IITA**

The alignment of corporate services of WARDA and IITA is expected to be completed by December 2007. All aspects of corporate services are expected to be covered during this

alignment process—which will thereby affect both Centers’ management of financial, physical (PPS, materials), human, and information resources.

Since each Center currently has different systems and policies—with different strengths and drawbacks—these efforts to harmonize and integrate the corporate services of the two Centers could change (to a larger or smaller extent) the systems currently used in both Centers. For example, WARDA currently uses the Sun system for financial and materials management, while IITA uses the Oracle system; and both Centers may need to make adjustments so that relevant financial and budgetary information can be transferred seamlessly from one Center to the other after the alignment.

The two Centers’ procurement systems too are different; and an external consultant has recently comprehensively reviewed IITA’s materials management system. The improvements introduced in IITA could provide an impetus to improve WARDA’s procurement processes as well, when the two systems are harmonized. A similar exchange of ideas and good practices would be useful in the areas of human resources management, information and communications, and physical plant services, so that the systems that finally get adopted for use at the Cotonou station—where the provision of corporate services to both Centers will be the responsibility of WARDA—is better than the system currently in use at either Center.

Put differently, and as stated in the Memorandum of Agreement (MoA) between IITA and WARDA signed in April 2007, the Corporate Services staff of both Centers are now expected to collaborate closely with each other to jointly plan, design, and implement the new administrative systems that will be used by WARDA after the alignment of corporate services. This will require staff of both Centers to make extra efforts to work across Center-boundaries, and to think and work differently than seems to have been the case thus far.

The two Centers’ recent experience in dealing with human resource issues related to the alignment illustrates this. The Heads of Corporate Services and HR Managers of both Centers have an opportunity to jointly address the complex HR issues involved in “transferring” NRS/GSS staff from IITA to WARDA. These potential problems, if not managed well, will affect both Centers, since they share common physical facilities at Cotonou and will soon be sharing many GSS staff as well. Both Centers have recently appointed professionally qualified HR Managers, and IITA has recently recruited a new DDG (Support) who will join in August 2007. Hopefully these new appointees would, in their mutual interest, work on these HR issues as one team, as will the joint “Transition Task Forces” that have recently been appointed for HR, finance, computers, purchasing, PPS, and general administration. The two Centers have also appointed a Transition Steering Committee, and have jointly hired three external consultants from Benin for advising the Centers on matters relating to government liaison, legal requirements, and HR options and processes. These are commendable steps.

It is expected that this team approach would prove very useful for discussion and harmonization of *all* corporate services that will be used by both Centers located at Cotonou—even though administratively the provision of such services will be the responsibility of WARDA. As per the MoA, a Local Implementation Committee is expected to be set up, to “oversee the site specific aspects of the agreement”. Its role “is to prepare annual budgets and work plans for approval by the AMC [Agreement Management Committee], and to ensure their implementation”. The AMC is expected to “approve annual budgets, provide guidance to the Local Implementation Committees and to arbitrate on issues when necessary.”

The realignment process is complex, will require flexibility both in the design and implementation phases, and could take longer than the six months provided for the entire process to be completed. The newly appointed Task Forces and Steering Committee seem to be on the right track, are moving forward slowly but steadily, and are fully aware of the difficult task ahead. The Panel therefore believes that instead of trying to meet the arbitrary deadlines specified in the MoA, the alignment proceed with due care and diligence, even if the process takes a little longer than originally expected.

As the two Centers move ahead with alignment of their corporate services, it would be useful to benefit from the experience of other CGIAR Centers that have recently aligned their corporate services. For example, the model being followed by IWMI and WorldFish—who have agreed that a newly-formed organization titled International Research Support Services (IRSS) would deliver outsourced corporate services to them, covering Finance, HR, and IT—is quite different from the approach adopted by WARDA and IITA. While it may be too early to know if this model will work as intended, the IRS seems to have started on a promising note. The experience of ILRI and ICRAF, the two Centers headquartered in Nairobi that have agreed to align selected corporate services could be instructive as well. Both these examples could provide lessons that might apply to WARDA and IITA.

In view of the complexity, long-term importance, and strategic implications of the alignment of corporate services for WARDA and IITA, and the potential for severe adverse consequences of possible communication gaps between the two Centers during the still-evolving harmonization process, *the Panel recommends that the staff and heads of Corporate Services of WARDA and IITA: a) continue a very collaborative approach to ensuring that the transfer/alignment of corporate services proceeds smoothly; b) closely monitor on a regular basis the progress made by the various Transition Task Forces, Steering Committee, and the Local Implementation Committees at Cotonou and other sites covered by the Memorandum of Agreement; and c) seek to benefit from the experience of other Centers that are aligning corporate services. Nevertheless, it cautions WARDA that in seeking efficiency gains from the alignment of corporate services, it ensures that research quality and relevance are not compromised, and that scientists continue to have access to adequate technical support during and after the alignment process.*

## **6.6. WARDA's planned return to Côte d'Ivoire**

WARDA's headquarters remains in Côte d'Ivoire where the M'bé location represents a 40 million USD investment (at the original investment value) in infrastructure from its Member countries. After the move to Cotonou in January 2005, the Board of Trustees defined a planning horizon of five years, in order to ensure stability to staff and programs. Thus, the earliest return will be in 2010 in the best of circumstances regarding political stability in Côte d'Ivoire.

It is to be noted that the Board of Trustees and the Council of Ministers of WARDA played a major role in taking timely decisions on relocation and in ensuring a measure of continuity and stability. Some donors also compensated partly the financial loss incurred by staff exodus, loss of all vehicles, laboratory equipment and relocation expenses. Moreover, the senior management team led by the Director General showed remarkable resilience throughout the turmoil and never put the future of WARDA as an institution and as an Association at risk. The fact that WARDA is an Association of Member States, besides a CGIAR Center, proved to be an important asset during its darkest days. That WARDA is in its present vibrant state today as a

performing CGIAR Center, temporarily located in Cotonou, is testimony to the resilience and robustness of the Association, and its importance in Africa.

The Panel Chair accompanied by the Director General visited M'bé on April 6, 2007. The station is in excellent condition, with no damage whatsoever to the physical infrastructure, all utilities are fully functional, and the buildings and grounds are being maintained. The genetic resources collection is in good condition and is being maintained. A former IRS scientist, as consultant, supervises the local staff at Bouaké, ensures the management and maintenance of M'bé, and oversees foundation seed production (100 t for the Government of Nigeria). A security detail (from the New Forces) is in place, and is being paid by WARDA at a small cost. Political conditions allowing, nothing would prevent a return to M'bé in terms of working conditions. However, the city of Bouaké is not yet hospitable to international staff, with all commercial banks still closed, no international schools nor adequate medical facilities nor a decent hotel, nor functioning gas stations. In many aspects, it was still a ghost city, ravaged by war, at least at the time of the visit.

Hence, WARDA could prepare for a return to Bouaké, political, security and living conditions permitting, at the earliest in 2010, and possibly later. *A second failed return cannot be permitted.* This does not mean that certain WARDA operations such as station testing of new varieties, breeder seed production and even certain laboratory tests could not take place in M'bé during the intervening years.

On the SC issue whether WARDA has an appropriate plan of action regarding infrastructure and installations left behind in Côte d'Ivoire and what further steps should WARDA take regarding its planned return to Côte d'Ivoire, the answer is that WARDA infrastructure at Bouaké in Côte d'Ivoire is well maintained, and a plan to continue this maintenance is in place and is being implemented. Operations there are limited to seed production and germplasm management/regeneration. WARDA has nominated a representative in Côte d'Ivoire based in Bouaké and who oversees both technical and administrative matters. It is hoped that a return to the headquarters will take place when the security conditions are in order and based on United Nations norms. A strategic plan on this issue has been developed and shared with the WARDA Board of Trustees. No further steps are warranted at this moment regarding the planned return to Côte d'Ivoire in the future.

## **6.7. Concluding comments on Governance and Management**

Clearly, during the period under review, WARDA has had to face extraordinary circumstances beyond its control, as outlined in Chapter I. The 4<sup>th</sup> EPMR recommendations on governance and management have largely been implemented, as noted in Chapter 1, or were overtaken by events. The difficulty of guiding and managing a Center repeatedly uprooted from its home country and headquarters location due to violent civil unrest should not be minimized; nor should the time and effort needed to firmly re-establish it on a firm footing in subsequent years. WARDA has only now emerged from this five-year period of uncertainty and flux. In recent years, it has performed reasonably well in terms of the CGIAR Performance Measurement System that includes a comparative assessment of governance, as well as on the financial and other management-related performance measures included in the CGIAR report for 2006. The Board and Management are taking this performance monitoring and reporting seriously, and follow-up actions and improvement are likely in coming years, where needed.

In the Panel's view, governance at WARDA is reasonably good, though program oversight could be improved. Management of research and corporate services has improved, though there is room for further strengthening in several areas, as suggested above. Moreover, the Center is still undergoing a further period of transition—with a new Director General, who assumed office in October 2006; a new "vision" and research organization introduced by him soon thereafter; and several new staff in important positions. In addition, it is expected that the planned alignment of corporate services between WARDA and IITA (Benin) will be completed by end-2007; a new ADG for Research and Development will be appointed upon the retirement of the current incumbent sometime during 2008; and programmatic alignment between WARDA and other CGIAR Centers will accelerate.

It seems to the Panel, therefore, that during the next 3-5 years, WARDA would benefit from a period of Board-guided and Management-orchestrated stability and consolidation, which would nevertheless introduce necessary changes in governance and management in a systematic and prudent manner. Once these changes are made, however, we believe WARDA would have the capacity to deliver a much more ambitious research program in the coming years.

## **7. WARDA TOMORROW**

### **7.1. The Context**

In many countries of SSA, rice production is keeping up with the population increase (2-3% per year) and even surpassing it. But with rice consumption in WCA increasing at 6% per year on average, the battle is still being lost in terms of reducing imports. Many factors explain this. However, with increasing world market prices (since 2003), rice farmers in SSA are getting higher prices, and local competitiveness is increasing. In addition, with improved technology and expanding areas under rice - uplands, lowlands, irrigated - a catch up on growing imports is possible. Several studies have shown the great potential for increasing local rice production and for reducing rural poverty and enhancing economic growth in the humid, sub-humid and Sahelian (irrigated) environments. This is because the economic multiplier effects in the rice value chain, from input supply, to production, to post-harvest processing and marketing are large, creating a lot of employment for both women and men.

### **7.2. WARDA's comparative advantage**

WARDA's comparative advantage is obviously in strategic and applied research on rice, and in facilitating policy work on rice production and marketing in SSA, as well as on nutrition and livelihood issues linked to rice. As a relatively small, commodity-based Center, clear priorities need to be set for its research program and outreach/technology transfer activities. Over the years, and in order to foster impact, WARDA has moved towards the development end of the research-development continuum, mainly through its partnerships and networks, e.g. in CBSS and foundation seed production through ARI. Just breeding more NERICA varieties and putting them through PVS will simply not produce the quantum productivity effects that WARDA is aiming for. The agro-ecological and socio-economic environment needs to be better stratified; and research, including breeding and other research activities at WARDA, need to consider this. This will produce new insights and knowledge for producing IPGs that allow more focused interventions in the diversified rice environments in which rice is grown in SSA.

### **7.3. Rice Technology Generation and Dissemination - the Scientific Challenge**

WARDA is at the center stage of rice technology generation and dissemination for the region. Until now, a lot of emphasis has been put on genetics and breeding, including the generation of interspecific (NERICA) varieties. About 6.7 % of all rice grown in the uplands of WCA is under NERICAs, after about 5-10 years of effort. This is already a remarkable achievement, taking into account that the uplands are a complex rice environment, and the many constraints to adoption.

Part of the problem is that NERICAs are still a generic recommendation, not tailored to specific local agro-ecological and socio-economic conditions. Africa is very heterogeneous. Moreover, NERICAs, even if there are now 18 upland, 60 lowland and 3 irrigated NERICA varieties, are still not bred for specific conditions. Moreover, the genetic base of NERICAs is fairly narrow. In addition, the underlying factors behind NERICAs' performance under stress conditions such as drought, low soil fertility, heat, water stress, pests, and weeds are still not known. In the coming years, research needs to address the production of varieties better targeted to the different agro-ecological niches of the three major ecosystems. Among new varieties, a large place will certainly be taken by a second generation of NERICAs with a broader genetic basis, and possessing better weed competitiveness. It is likely as well that some of the newly produced varieties will carry



favorable alleles of resistance to RYMV and/or tolerance to submergence, and/or tolerance to salinity, introduced by marker-aided selection into elite locally adapted varieties. Progress is also expected in understanding the genetic and physiological factors controlling traits of agronomical importance, such as drought resistance or iron toxicity, either through classical genetic mapping approaches, or through whole genome association mapping, both in *O. sativa* and in *O. glaberrima*.

#### **7.4. NRM**

Thus far, WARDA has put major emphasis on genetic improvement, and on adapting rice varieties to marginal environments. Managing the environment to bring out the genetic potential of different varieties needs much more attention (soil and water management, agronomy), as do post-harvest issues. In addition, the area under rice has been expanding into marginal upland and poor lowland areas, resulting in lower yields. Even in good soils with inappropriate crop and natural resource management, yields may decrease after a couple of years due to nutrient mining and other forms of land degradation. Future research should focus on the development of NRM practices to sustain long-term rice production in Africa.

In tailoring NERICA and other WARDA varieties to more context-specific conditions, the agronomy of rice, NRM issues, and the social sciences will need to come to the fore, and receive more attention. It has become clear that the agro-ecological environment in a broad sense, including farm management practices, also needs to be changed in order to realize the genetic potential. Under poor management conditions, the best NERICA varieties remain low yielding and yields are not sustainable. What are the recommended agronomic practices (optimum sowing date, spacing, density, fertilization, weed control, water management and control) for each variety in each environment?

#### **7.5. Seed Production**

Seed production will remain a major constraint on adoption and diffusion of NERICA and other WARDA varieties. Because the private seed sector in SSA is underdeveloped, the public sector needs to step in. The small emerging private seed entrepreneurs and CBSS need public support, or at least need to be protected against dumping at low seed prices by the public sector, as happens in certain countries. This is a difficult issue. Ideally, WARDA should only engage in breeder seed production (and temporarily, in producing some foundation seed) and training and capacity building on seed issues. But this has proven insufficient to meet demand for seed. As private foundations are now moving to address the seed challenge, the pressure WARDA to get more involved with seed production, including from its COM and NEC, should be less. It remains unclear why farmer-to-farmer seed exchange and adoption often remains minimal. WARDA's socio-economists need to monitor the adoption of new varieties (and disadoption), the seed issue and impact of new varieties. In addition, the reasons for adoption or non-adoption need to feed back into WARDA's breeding and NRM programs. Ideally, mixed, interdisciplinary teams should do the adoption and impact studies.

## **7.6. The Policy Environment**

Regarding the policy environment and policy research and advocacy, the main advantage in SSA is that the rice market is there, and is growing fast. No major efforts are needed to create a market or make it grow. Furthermore, most countries protect domestic rice production to some extent, by imposing import duties. There is an issue of discounts on local rice due to poor quality compared to imports needs to be addressed throughout the local rice value chain, including post-harvest (milling, purity, uniformity) and marketing (packaging, branding). This problem needs to be tackled through the creation of appropriate institutions for local value chain enhancement and development, and public support may be crucial for appropriate institutional innovations to occur. Additional public resources are needed to support rice research, in line with countries' declared aims of attaining more self-reliance in rice and better food security.

WARDA needs to constantly monitor the rice policy environment in SSA, and undertake the policy research needed for policy advocacy, activities for which WARDA is well placed. The Center needs to take full advantage of its Association status, its Council of Ministers, National Experts Committee and APRAG, to create a more conducive environment for local rice production and marketing and rice research and development.

## **7.7. Training and Capacity Building**

Training and capacity building remain a continuing challenge for WARDA, as NARS get stronger and undertake on more of the applied and adaptive research. The demand for keeping up with new technologies and methodologies is huge, particularly in topics like molecular biology, crop modeling, post-harvest, NRM, spatial analysis, and socio-economics. Because capacity building for rice research in the mandate region is not only a moral obligation but also an excellent investment, WARDA has an obligation to train as many scientists and research technicians as its budget allows. In addition, such capacity building has to be at all levels, from research technicians to Ph.D.s. Under budget constraints, the temptation is always to cut back on training, wrongly assuming this does not affect the main research program; while in fact it does, as training is part and parcel of WARDA's core activities.

## **7.8. Future scenarios**

Before the next EPMP, WARDA may have returned to M'bé in Côte d'Ivoire, political and security conditions permitting. By then, WARDA will hopefully have become a US\$ 15 to 20 million Center with increased scientific capacity and stronger scientific standing. The infrastructure facilities at M'bé are spacious and first class, allowing excellence in research. By then also, the IRRI-CIAT and IITA collaboration will hopefully be commonplace, resulting in synergies, more critical mass, new insights, more efficient (molecular) breeding, and a better understanding of genotype x environment interactions.

Future events in Nigeria, as a mega-country for rice in SSA, and a special focus of WARDA, will have particularly important implications for WARDA's success in SSA. With the Presidential Initiative on Rice, a strategy declared at the highest level to develop rice production, and good technology, Nigeria could turn the corner on rice imports, and set an example for the rest of Africa. If 70 to 80% of the poor in Nigeria are rural, as elsewhere in SSA, and are mainly engaged in agriculture, how else can they escape from poverty, but through increased agricultural productivity?

In the future, WARDA should remain an agile Center, with a strong headquarters that coordinates work in Cotonou and in several outstations, including in Nigeria, St.-Louis, Bouaké and Tanzania. Ideally, all outstations should have critical mass to meet the subregional challenges in the different rice agro-ecologies and socio-economic environments. WARDA needs to build on its successful partnership model further, in order to seek more effective collaboration on problem identification, cutting-edge science, applied research, and dissemination of results. At the same time, transaction costs in networking and partnerships need to be controlled, and shared more evenly with partners.

WARDA tomorrow—as the Africa Rice Center--will be a reputed CGIAR Center, known for its excellence in rice research in SSA and in the world, and will also have successful networks and partnerships with the NARS, advanced research institutes and CSOs. This is the scenario that the Panel has in mind.

The verdict on a rice-led green revolution in West Africa is still out, while the challenge for more rice production in Central, East and southern Africa is growing fast. The yield gap remains a daunting challenge, and not just for rice in SSA. With adequate resources from Member countries (the number of Member States in the Association is increasing) and donors, and with a focused and impact-oriented research program, WARDA (with its partners) can deliver on the promise of putting more rice on the tables of poor and hungry people, of putting more money into their pockets, and of contributing in this way to the daunting challenge of the MDGs.

**ANNEX I**  
**WARDA 5th EPMR Panel Composition and Biodata**

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**Expertise:** Agricultural Economics, Agricultural Marketing, African Agricultural Research.

**Education:** Ph.D. Agricultural Economics, Michigan State University (1975); M.A. Economics, Michigan State University (1971); Agricultural Engineer, K.U.Leuven (1967).

**Experience:** 2001-present: Member Scientific Committee of the Sahel Institute (INSAH), Bamako, and Regional Centre AGRHYMET, CILLS, Niamey; 2001-present: Member Scientific and Technical Council of ISRA, Dakar; 2001: Member of the Evaluation Team of PRASAC, DGCID, Paris; 2000: Consultant to the World Bank on the rice market situation in Liberia and the scope for a rice market information system; 2000: Participation in GFAR meeting in Dresden as Belgian representative; 1999-present: Member Scientific Committee PRASAC, now ARDESAC, N'Djaména; 1998-2004: Member of the Jury, King Baudouin Prize for Development Cooperation; King Baudouin Foundation, Brussels; 1998: Member of the External Evaluation Teams of PSI-CORAF, Dakar; 1997-1999: Member IFAD External Research and Development Panel; 1995-1997: Vice-President and Treasurer of NATURA; 1997-present: Member of the Advisory Committee of CTA, Wageningen; 1985-present: Vice-President of the NGO ACT, now TRIAS; 1983-present: Professor of Agricultural Economics, K.U.Leuven; 1979-1983: Administrator, Commission of the European Communities, EUROSTAT, Luxemburg; 1977-1979: Professor of Agricultural Economics, K.U.Leuven; 1971-1977: Professor of Agricultural Economics, Université Lovanium and Université Nationale du Zaïre, Yangambi.

CGIAR: From 2007: Member of the Board of ICRAF, Nairobi; 2006: Member Technical Team, Independent External Evaluation of FAO; 2005: Member of the NATURA-ECART monitoring mission to ICRISAT (biotechnology), India and Kenya, for the EC; 2004: Member of the NATURA-ECART monitoring mission to WorldFish Center, genetic improvement of fish, Malaysia and Philippines, for the EC; 2003: Member of the NATURA-ECART monitoring mission to CIP, Peru and Bolivia, project 7B (genetic resources), for the EC; 2000-2001: Member WARDA 4th EPMR Panel; 1998-2004: Member of the Board of Trustees, IITA, Ibadan; 1989-1990: Member IITA External Program Review; 1990-1995: Member European Scientific Advisory Committee IFPRI; 1988-1991: Consultant CGIAR Task Force on sub-Saharan Africa (maize and cassava).

**COURTOIS, Brigitte (FRANCE)**

**Position:** Since 2000: Cirad-AMIS, France: Crop geneticist, head of the Bioinformatics team of CIRAD Biotechnology Unit

**Expertise:** Plant breeding and genetics rice; genetic data analyses, project management.

**Education:** PhD in Genetics and Plant Breeding (1981), University of Montpellier, France, Thesis on "Variability of the progenies of 3 rice crosses fixed by anther culture and single seed descent"; MSc in Plant Breeding (1978), ENSA Montpellier, France. Thesis on "Genetic improvement of apricot and almond tree earliness by gamma irradiation"

**Experience:** 20 years of experience in plant breeding and genetics, mostly on rice (genetic resources management, conventional breeding, molecular genetics, quantitative genetics, marker-aided selection; participatory plant breeding; biostatistics) with focus on drought resistance, disease resistance, interference with weeds, and grain quality. 1999-1993: Cirad-CA upland rice breeder and geneticist seconded at the International Rice Research Institute, Los Baños, Philippines; 1985-1992: Cirad-CA, Upland rice breeder, Guadeloupe, French West Indies. Published on genetic improvement of rice and other tropical crops (cocoa, cotton, oil palm, sorghum, sugar cane, taro).

**MENETE, Zelia (MOZAMBIQUE)**

**Position:** Since Oct 2005: Director General of the Manica Polytechnic Institute; since 2006 Associate Professor at the Faculty of Agronomy and Forestry Engineering at the Eduardo Mondlane University (UEM).

**Expertise:** Southern Africa, soil science, water management, rice yields and soil research, environmental issues, higher education systems, remote sensing and GIS

**Education:** 2005 PhD in Strategies for improving rice yields on salt-affected soils of the Chokwé irrigation system, Mozambique, Dept Crop and Soil Sciences, Cornell University, Ithaca, New York; 1993 MS in Soil & Water Management specializing in Land Evaluation & Soil Survey Remote Sensing and GIS, Wageningen Agricultural University, The Netherlands; 1990 BS Hons. in Agronomy Eduardo Mondlane University (UEM), Maputo, Mozambique

**Experience:** 2005-2002 Environmental and capacity building adviser at Matola City Council (2003-4); Assistant Professor and Advisor to the mayor of Matola in all environmental and capacity building aspects, specifically on environmental planning and management, staff training, laws and regulations; 2001-1998 Director of Studies at the Department Rural Engineering at the Faculty of Agronomy and Forestry Engineering (FAEF) and coordinator of GRNB (Grupo de Gestao de Recursos Naturais e Biodiversidade) – a Faculty consultancy group; 2000-1998: Part-time councillor for rural development and environment at Matola City Council; 1997-1994: Assistant Professor at UEM and consultant for GRNB; 1997-1996: Part-time technical advisor of Finnagro (Finish organization) at SATIM Project in Boane, Mozambique; 1991-1990 Lecturer at UEM, Faculty of Agronomy and Forestry Engineering (FAEF); 1988-1989 Teaching assistant UEM. Has also done consultancies for the Ministry for Environmental Affairs, Ministry of Education, Maputo-Mozambique, ACOPS, Swiss Development Cooperation (SDC), the Irish Embassy in Maputo, DGIS in the Netherlands Embassy in Maputo, Helvetas (ONG), The World Bank through a project in Ministry of Planning and Finance and also with the Ministry of Higher Education Science and Technology. Member of the Scientific Committee in Agriculture (advises the Government of Mozambique in Agriculture related issues) and the Soil Science Society of America (SSSA).

**SACHDEVA, Pammi (USA)**

**Position:** Independent Consultant, since 2001

**Expertise:** Program and institutional assessment, recruitment, and human resource management in the agricultural research and public health sectors

**Education:** Ph.D., Social Systems Sciences, the Wharton School, University of Pennsylvania, Philadelphia, 1988. Specialization in systems approach to organizational analysis, planning and management. MBA, the Indian Institute of Management, Ahmedabad, 1971. Major in organizational behaviour and human resource management.

**Experience:** Recent clients include the World Bank, FAO, WHO, Islamic Development Bank, and the Global Water Partnership. Prior to this, he worked for over twenty years in the World Bank and the CGIAR, retiring in 2001 as adviser. At the CGIAR Secretariat, he undertook or facilitated comprehensive assessments (EPMRs) of the governance, strategy, programs, organization, and management of twelve of the fifteen CGIAR-supported international agricultural research Centers; and served as member of the CGIAR gender and diversity advisory board, and of various CGIAR task forces and working groups. At ISNAR, he served as Chair of HRM working group and head of training program; and led a research project on the organization and structure of national agricultural research systems in developing countries. He has undertaken work-related travel to over thirty developing countries.

**HASEGAWA, Toshihiro (JAPAN)**

**Position:** Since 2006: Senior Researcher Agro-Meteorology Division, National Institute for Agro-Environmental Sciences

**Expertise:** Rice, agronomy

**Education:** Doctor of Agriculture (1996), Thesis on: Modeling the effect of nitrogen on rice growth and development; Masters of Agriculture 1988, Bachelor of Agriculture 1985; all from Kyoto University.

**Experience:** 2003 Chief, Atmospheric Impacts Unit, Department of Global Resources, National Institute for Agro-Environmental Sciences; 1999 Associate Professor, Graduate School of Agriculture, Hokkaido University; 1997 Assistant Professor, Faculty of Agriculture Hokkaido University; 1994 Assistant Professor, School of Agriculture, Kyushu Tokai University; 1990 Research Instructor, School of Agriculture, Kyushu Tokai University; Crop Science Society of Japan Research Award for Young Scientists (1998): "Modelling the effects of nitrogen nutrition on rice growth and development". Widely published on rice management and improvement Member of the Crop Science Society of Japan; American Society of Agronomy; Society of Agricultural Meteorology of Japan

**NCUBE, Mary (ZAMBIA)**

**Position:** Since 1997: Chief Executive, M T Ncube and Associates

**Expertise:** Auditing, financial management, corporate governance

**Education:** 1988-1984 Associate of the Chartered Institute of Certified Accountants (ACCA), London School of Accountancy/ Zambia Centre for Accountancy Studies; BA, Economics 1982, University of Zambia

**Experience:** Ms. Mary Ncube has over 23 years working experience as a consultant, accountant and auditor. She spent sixteen years with KPMG Peat Marwick, Zambia where she began as an Audit Assistant in 1982. In 1991 she was promoted to Audit Manager, and was admitted to Partnership in 1995. She is the first female of African descent to have been admitted to Partnership in KPMG globally. In addition to accountancy and finance related work, Ms Ncube has worked with a number of organisations on assignments related to economic and organisational development and management of aid and project funds including USAID, NORAD, World Bank, UNDP and UNHCR.

Professional memberships are: fellow member of the Association of Chartered Certified Accountants (ACCA); Fellow member Zambia Institute of Chartered Accountants (ZICA); member of the Institute of Directors of Zambia and the Economics Association of Zambia. Also a Council member of the Medical Council of Zambia; a Tribunal Member of the Zambia Revenue Tax Appeals Tribunal, Board member to the HIVOS, Zambia; Chair Bank Audit Committee- Stanbic Bank Zambia, Director Energy Regulation Board of Zambia, Director on M.T.N. Special Engagements Limited (a consultancy firm) and M.T.N. Boardroom and Conferences Limited; and a member of the UN Conference on Trade and Development (UNCTAD) Group of experts on International Standards of Accounting and Reporting. Previous Directorships include: Director on Zamnet Communications Systems Board; Council member, Zambia Institute of Chartered Certified Accountants; Chairperson ZAMCOM Lodge Board; Treasurer, Zambia Women's Lobby; Chairperson, Audit Committee of Lusaka International Community School; Chairperson, Women's Capital Development Fund, Steering Committee of Securities and Exchange Commission (SEC).

## ANNEX II

### **a. Guidelines for External Programme and Management Reviews of CGIAR Centers, including Terms of Reference for External Programme and Management Reviews of CGIAR Centers**

#### **INTRODUCTION**

In June 2005 the CGIAR approved the policy document, *Monitoring and Evaluation System for the CGIAR Centers*. The new components of the monitoring and evaluation (M&E) system include annual performance measurement (PM), Center Board Commissioned External Reviews (CCER) and streamlined External Program and Management Reviews (EPMR).

EPMRs are commissioned by the SC on behalf of the Group and organized jointly by the SC and the CGIAR Secretariat. They are conducted every five years for each Center. These Guidelines are to be used in implementing the EPMR as part of the new M&E process. They incorporate the Terms of Reference for EPMRs (TOR) as endorsed by the Group in 1997. They do, however, bring new approaches to the EPMR based on an enhanced Center Board Program for CCERs. The guiding principles for the Center Boards to implement CCERs are attached (Annex 2).

In the new M&E system, EPMRs continue to provide a measure of central oversight and serve as an essential component of the CGIAR's accountability system. The EPMRs bring to a closure a five-year review cycle. They complement the annual Science Council (SC) assessment of the MTPs, the annual self-assessment mechanisms of the PM, and the CCER Program of the Boards, covering the Center's research Program and management.

These Guidelines have been designed for review of a Center. A companion Guideline will be developed for the External Reviews of Challenge Programs based on the same principles.

#### **TERMS OF REFERENCE FOR EPMRS<sup>114</sup>**

##### **Objectives and Scope**

EPMRs seek to inform CGIAR members that their investment is sound, or recommend measures to make it so. Members of the CGIAR and other stakeholders can be informed whether the Center is doing its work effectively and efficiently. EPMRs are both retrospective and prospective and help ensure the Centers' excellence, relevance and continued viability, and the CGIAR System's coherence. Each review is expected to be strategic in orientation and as comprehensive as the situation warrants.

The broad objectives of EPMRs are to: a) provide CGIAR members with an independent and rigorous assessment of the institutional health and contribution of a Center they are supporting; and b) to provide the Center and its collaborators with assessment information that complements or validates their own evaluation efforts, including the CCERs.

The EPMR Panel is specifically charged to assess the following:

1. The Center's mission, strategy and priorities in the context of the CGIAR's priorities and strategies;
2. The quality and relevance of the science undertaken, including the effectiveness and potential impact of the Center's completed and ongoing research;
3. The effectiveness and efficiency of management, including the mechanisms and processes for ensuring quality; and
4. The accomplishments and impact of the Center's research and related activities.

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<sup>114</sup> As endorsed by the CGIAR in 1997.



## **Topics to be covered**

### ***Mission, Strategy and Priorities***

- The continuing appropriateness of the Center's mission in light of important changes in the Center and its external environment since the previous external review.
- The policies, strategies, and priorities of the Center, their coherence with the CGIAR's goals (of poverty alleviation, natural resources management, and sustainable food security), and relevance to beneficiaries, especially rural women.
- The appropriateness of the roles of relevant partners in the formulation and implementation of the Center's strategy and priorities, considering alternative sources of supply and the benefits of partnerships with others.

### ***Quality and Relevance***

- The quality and relevance of the science practised at the Center.
- The effectiveness of the Center's processes for planning, priority setting, quality management (e.g., CCERs, peer reviews and other quality and relevance assurance mechanisms), and impact assessment.

### ***Effectiveness and Efficiency of Management***

- The performance of the Center's Board in governing the Center, the effectiveness of leadership throughout the Center, and the suitability of the organization's culture to its mission.
- The adequacy of the Center's organizational structure and the mechanisms in place to manage, coordinate and ensure the excellence of the research programs and related activities.
- The adequacy of resources (financial, human, physical and information) available and the effectiveness and efficiency of their management.
- The effectiveness of the Center's relationships with relevant research partners and other stakeholders of the CGIAR System.

### ***Accomplishments and Impact***

- Recent achievements of the Center in research and other areas.
- The effectiveness of the Center's programs in terms of their impact and contribution to the achievement of the mission and goals of the CGIAR.

## **CONDUCTING EPMRs**

In the new M&E system, EPMRs become increasingly an audit of the other components: annual PM and CCERs. Beyond the broad objectives stated in the TOR, the EPMRs are meant to provide Centers with independent recommendations and advice on how to improve the efficiency and effectiveness of the Center in pursuit of its mission and goals. Thus, the EPMR report is both an audit on past performance and a strategic document with a focus on the Center's future. Specifically, EPMR needs to advise on what changes the Center might consider in terms of its programmatic strategy and objectives; what new avenues of collaboration and partnership it might consider; and what structural changes the Center might consider in pursuing more efficiently and effectively its mission and goals.

The EPMRs are designed to complement and build on the CCERs by providing a more strategic overview of the performance of the Center. The PM provides inputs to both CCERs and EPMRs. To be credible and acceptable, all CCERs and EPMRs must strive to be objective and transparent. While the EPMR process must be participatory to enhance mutual understanding of all the important issues, the distance between the Panel and the Center must be observed to protect the Panel's integrity and

independence. The reports must be direct, explicit and frank. These principles are observed throughout the review process.

### ***The Participants***

The participants in an EPMR are: the EPMR Panel Chair and members; the CGIAR Members, the SC, the SC Secretariat and the CGIAR Secretariat; the Panel Secretary; members of the Center's Board, management and staff; the Panel's support team of external consultants and resource persons; Chairs of CCERs (as resource persons where possible); and the Center's many partners at the local, national, regional and international levels.

### ***Strategic Issues to be addressed by the Panel***

In addition to the generic TOR for each EPMR which have been approved by the Group, the SC identifies a set of Center specific issues to be addressed by the Panel. The SC does this by canvassing views from SC members, CGIAR Members, the Center under review, other CGIAR Centers and the CGIAR Secretariat. Items are also drawn from the CCERs and the SC assessment of the Center's Medium-Term Plans. The list of issues is shared with the Center and the Panel as specific strategic issues to be addressed during the review.

### ***Implementation***

The SC and the CGIAR Secretariat jointly organize the EPMRs. The SC focuses on all programmatic aspects and the CGIAR Secretariat focuses on Center management and governance aspects of the review. Consulting with the Center management as necessary, they determine review design and Panel composition.

The SC and CGIAR Secretariats provide a resource person for the respective aspects of the review. A staff member of the SC Secretariat serves as Panel Secretary and resource person for programmatic issues. S/he assists in organising the review in consultation with the CGIAR Secretariat, the Center, the Panel Chair and members.

The EPMR relies heavily on Board commissioned CCERs, which are expected to greatly improve the efficiency of the EPMR process.

The EPMR schedule consists of the pre-implementation phase (preparation by the Center, SC and the CGIAR Secretariat), Panel interaction with the Center Board, usually through attendance at a Board meeting; Initial Phase visit to the Center HQ, which may take place back-to-back with the Board meeting; visits to selected field sites as deemed necessary by the Panel Chair; and a Main Phase also at the Center HQ during which the Panel completes all the chapters of the report.

### ***The Pre-implementation Phase***

The pre-implementation phase of the EPMR begins with the Board ensuring they have in place an adequate cluster of CCERs. The *Principles* suggest that CCER to be effective for the EPMR should be reasonably current, i.e. within 3 years of the EPMR. The following steps are needed: The SC Director will send a formal letter to the Center three years before the EPMR begins with a request to the Board to provide a schedule of the CCERs to be conducted during the three year period leading into the review.

The CCER reports, including the Panel membership and their qualifications, and an account of the follow-up actions planned or taken by the Center Management and Board are made available to the SC and CGIAR Secretariats at the onset of planning of the EPMR.

### ***The EPMR Panel Profile***

The design of the EPMR and the Panel composition depend on the coverage and quality of the CCERs. The SC and CGIAR Secretariats brief the Panel Chair on the strategic issues raised and on the information available from the CCERs. The final design of the EPMR, including the Panel profile and size, will be adjusted with the aim of not duplicating the CCERs. The Panel will consider the CCERs and assess their quality as input to the EPMR.

### ***Panel Chair and Panel Members***

The quality of the outcome of the EPMR depends critically on the quality of the Panel Chair and the Panel members. In order to engage highly competent professionals, the EPMR process must be efficient, including timely planning. The Panel Chair and member selection process follows procedures established by the SC and the CGIAR Secretariat. The process of identifying a Chair begins about one year before the EPMR. The Panel Chair should be a recognized expert in a relevant area of research with considerable experience in research management and understanding of international agricultural research in the development context, have excellent analytical and leadership capability, and excellent command of English. S/he should have served on an EPMR or equivalent review outside the CGIAR and demonstrated capacity to lead an independent and objective review.

The Panel Chair is involved in determining the Panel profile and composition. For doing this, s/he is i) informed of the Center's and the SC's suggestions regarding Panel profile; ii) briefed by the Panel Secretary and CGIAR Secretariat resource person on the coverage of CCERs and whether they meet general criteria for quality; and iii) provided with a long list of potential Panel candidates. Direct contact with the CCER Panel Chairs by the SC Secretariat, CGIAR Secretariat or Panel Chair is advised. The Panel Chair is also briefed by the SC Chair about the overall goals and conduct of the review.

The Panel size should not exceed four, including the Chair. The Panel Chair will judge the need for consultants with specific skills to address particular aspects of the TOR. Panel members are generally selected for their ability to focus on the institution-wide issues relating to the Center's mission, strategy, priorities, programs, governance, and management. The Panel members should be drawn from a pool that has maximum regional and gender diversity; they are to be recognized experts in their field of expertise and the context of its application to solve problems; they must have good analytical skills and ability to write clearly and concisely in English.

The Panel Chair ensures that the Panel undertakes its assessment and completes the task in accordance with the general TOR and addressing the Center-specific strategic issues. The Chair assigns duties to each Panel member and encourages members to contribute to all aspects of the review report so that the report reflects the judgment of the whole Panel. S/he conducts the EPMR in a manner that is objective, analytical and constructive, and in a manner of mutual respect with the Center. The Panel Chair shares factual information with the Center for verification while maintaining independence in judgment.

### ***The Center***

The Center's Board, management and staff play a crucial role in the conduct of the review. They are closely involved in planning and organizing the review. Throughout the process, the collaboration and inputs of Center management and staff are essential for the review to run smoothly and for the report to be credible and acceptable. The Center should appoint one senior contact officer to facilitate the implementation of the review including compilation of all documents and information.

In preparation for the EPMR, the Board is expected to make available to the Panel a list of issues relevant to the EPMR. For this, the Board is encouraged to draw from the findings of CCERs and other relevant reports. The Center management provides appropriate material for the Panel following the instructions provided by the SC Secretariat and CGIAR Secretariat. Some of the material is expected to be readily available, while other documentation needs to be prepared specifically for the EPMR. The main documents include:

- The Strategic Plan of the Center or a strategic report from the Board on the Center's vision and goals showing how the Center will contribute to the CGIAR goals;
- An aggregate analysis of impact of the Center activities showing how the investment in the Center has contributed to outcomes and impact;
- A portfolio analysis on Center research including recent planning, i.e. the MTP reports for the period under review; and,
- Results of self-assessment processes including PM reports, CCERs and other relevant reports. All donor review reports should also be made available to the Panel.

A detailed list of documents and other materials to be provided to the Panel by the Center, SC and CGIAR Secretariats is given in Annex 1. The materials will be placed on a restricted Web site established for the EPMR, and distributed to the Panel on a CD-ROM prior to the Initial Phase. The Panel Chair and Secretary advise Panel members on specific reading tasks.

#### *Center Stakeholders*

Representatives of national agricultural research systems (NARS, including NGOs, universities and the Private Sector), regional and sub-regional organizations, bilateral and multilateral agencies, other researchers and managers of other Centers and Challenge Programs and advanced research institutions are important partners of CGIAR Centers, and their inputs are essential for the quality of the EPMR review process. As part of the review, these stakeholders' views on the Center's strategy, programs and collaboration and outputs and outcomes are gauged through two processes, which the Panel Chair defines in consultation with the Center and Panel members: a) Stakeholder survey by phone or e-mail, the results of which ought to be available to the Panel early on (the Panel may adjust its own survey if results of a recent Center conducted stakeholder survey are available); and b) Field visits. These consultations are intended to facilitate the assessment of the Center's role in the CGIAR and in the global context.

#### *Assessment of the Board*

Interactions between the Center Board and the Panel form an essential component of the review. Thus early in the process, preferably prior to the first visit of the full Panel to the Center (Initial Phase)<sup>115</sup>, the Panel Chair and Panel member specializing on governance issues attend a Board meeting and interview Trustees about the Board and Center matters. These interactions contribute to the Panel's assessment of the Board's efficiency and operations, and the rigor of the Board's oversight of research quality and relevance, management and finances, including the implementation of the CCERs. The Panel should observe the content and dynamics of Board procedures, Board and Management relations and evidence of the Board being fully engaged with all key matters, including setting the vision and goals, monitoring and evaluating performance, setting policies, preparing contingency plans and ensuring that resources are used effectively and efficiently.

The Panel members attending the Board meeting need to review both the documentation provided by the CGIAR Secretariat on CGIAR governance, the Center on legal matters, and documents provided

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<sup>115</sup> The Board meeting and EPMR Initial Phase should not coincide.

to the Board, including some recent Board Minutes. In addition to following the Board meeting, they need to observe the Board committees in action.

### ***Initial Phase***

The Initial Phase usually takes about a week. The Center, Panel Chair and Panel Secretary design the agenda of the Initial Phase. The visit includes sessions and discussions with Center management and key staff members in order for the Panel to obtain an overview of the Center's current activities and future plans, to identify strategic issues and formulate hypothesis for key findings. The key senior Center staff should be available in person during the Initial Phase.

Before and during the Initial Phase the Panel receives detailed briefings from the SC and CGIAR Secretariats on relevant recent developments in the CGIAR and the Center being reviewed, covering both technical and programmatic matters, and matters on governance, organization, finance and human resources.

The Panel holds internal briefings throughout the Initial Phase and, by the end of the visit, produces an outline of the report, including assignments for drafting the report sections. The recommendations of the previous EPMR and the Center's initial and updated responses to them are the Panel's point of departure, and the Panel provides an assessment of the progress on implementation in an appendix to the report.

During the Initial Phase the Panel Chair should request from the Center any additional information and documents deemed necessary for the Panel's work.

### ***Field Visits***

The Panel conducts a limited number of field visits as judged necessary by the Panel Chair in consultation with the Center. The CCER panel itineraries may influence the choice of the EPMR field visits. Small Panel sub-groups conduct these visits, each visit lasting about 3 days. The purpose of these visits is to provide a realistic assessment of the Center's field operations, working conditions, and interactions with NARS and others in the region. The Panel is encouraged to prepare a check lists for the visits so that the sub-groups gather similar information relevant for the report's conclusions.

One purpose of the field visit is for the Panel to interact with Center staff posted outside of HQ. Center staff are also responsible for logistical arrangements. However, Center staff does not participate in substantive discussions with country officials, clients or stakeholders. Center HQ staff do not accompany the Panel during field visits.

### ***Main Phase***

The Main Phase of the review lasts about 10 days and takes place at the Center HQ. By the time the Panel gathers for the Main Phase, first drafts of virtually every section of the report will have been shared with the entire Panel. It is desirable that comments to the first drafts will also have been circulated among the Panel. This is essential to enhance the Panel members' contributions to and agreement of the contents of the entire report and to free time for Panel discussions on the most important strategic issues, findings, conclusions and recommendations. The Panel members also need time to interact with key staff members for validating their hypotheses and confirming the information that forms the basis of their assessment. All Panel members need to agree on the final chapter drafts which are then shared with the Center management to ensure their accuracy and factual correctness. The Chapter relating to Board function is shared in confidence with the Board Chair for factual correctness. Also an executive summary and the key recommendations are shared with the Center management before the formal presentation to the Center staff.

At the end of the visit the Panel Chair presents the main findings and recommendations to the Center management and staff. The Center may invite a Board member to be present. The report is not distributed to the Center.

The final report is completed within two weeks from the main visit. It is expected that the Panel has fully finished writing the chapters and what remains to be done is editing, formatting and compilation of the annexes. The Panel Chair and Secretary finalize the report interacting with the members as necessary. The Panel Chair submits the report to the SC Chair and the CGIAR Director, copied to the Center.

#### ***The Panel's Report***

The report is expected to be succinct (less than 100 pages) and written in plain language, focusing on assessment of Center performance, in terms of research performance, management and governance, and strategic issues. The Panel is expected to make an independent assessment based on its own observations and other information available to it, particularly the evidence provided through CCERs.

The report comments on the effectiveness of the Center's internal review system on which the EPMR was based, and on how well the Center has addressed the recommendations of the other reviews commissioned by the Center. Every EPMR should have sections briefly addressing these two topics.

The report should make a limited number of clear recommendations on the most significant issues faced by the Center (or the CGIAR) to act upon. The recommendations should be clearly articulated, realistic and doable in terms of implementation. Where those recommendations require additional resources, the Panel will also recommend what activities could be foregone. EPMR Panel may also identify areas of Center activity where a follow-up study (e.g. CCER) would be desirable.

#### ***Assessment of Quality and Relevance of Research***

Assessment of the quality and relevance of the Center and its research programs are among the most important components of an EPMR. Furthermore, the PM system requires an assessment of the quality of Center research. The SC will provide the Panel with a set of criteria to be used by them to provide this assessment. In order to strengthen a systematic approach to this assessment by very different Panels evaluating very different Centers, the SC requests the Panel to provide both a qualitative and quantitative assessment for each criterion. The SC will use the Panel's assessment to provide the input into the PM process.

#### ***Response and Follow-up***

The Center Board and Management submit a formal written response to the EPMR report, addressed to the SC Chair and the CGIAR Director. Their response states the Center's agreement, or otherwise, with each recommendation and outlines the actions proposed for implementing the recommendations.

The SC discusses the report and the Center response in the presence of the Panel Chair, Center Board Chair and Director General. The SC prepares a commentary focusing on the programmatic aspects of the Report, and the CGIAR Secretariat prepares commentary focusing on governance and management. The commentary should provide an assessment of the quality of the EPMR report and an endorsement of all the recommendations or justification for not endorsing specific recommendations.

The EPMR report, the Center response, the SC commentary and the CGIAR Secretariat commentary are then submitted to the ExCo, which formulates its recommendations to the CGIAR for discussion and endorsement at AGM.

In the subsequent MTPs, the Center will report on actions taken to implement the Group-endorsed recommendations, including real changes in the MTPs of the projects and programs, until recommendations have been fully implemented. The SC and the CGIAR Secretariat will include an assessment on the implementation of the EPMR recommendations in their MTP commentary to ExCo and the Group.

The Panel's assessment of the Center's research quality will be incorporated into the PM process and be effective for the period between EPMR reviews. In the case where the PM assessment is poor, the SC will, based on the evidence of change at the Center review the PM assessment in the interval between the EPMR process.

A Mid-Term Review can be considered as an appropriate mechanism to monitor closely the Center's handling of major concerns raised by the EPMR.

## **ANNEX II**

### **b. Terms of Reference for the Financial Management Consultancy**

Within the context of the Terms of Reference (TOR) for the external review of the Africa Rice Center (ARC/WARDA), the review panel requires an independent expert review of financial resource and risk management aspects of the Center's overall operations.

To aid the panel in its work, the Consultant will review and critically assess the efficiency, effectiveness, and overall soundness of the management of ARC/WARDA's financial, physical, and informational resources.

This review is expected to take approximately 12 working days (of which at least 5 days will be spent at the ARC-WARDA headquarters in Cotonou, Benin).

The review will specifically address the following topics:

The adequacy of the Center Board's oversight of financial management issues;

the adequacy of the Center's financial controls, records and record-keeping, funds management, investment guidelines, banking arrangements, and the reporting of financial information throughout the organization;

The sufficiency, quality, integrity, and cost-effectiveness of the Center's internal and external audits.

The reviewer will examine recent reports, including Management Letters, to judge relevance, completeness, and compliance by management with the recommendations contained therein;

An assessment of the financial aspects of the Center's human resource management practices and policies,

A review of the adequacy of current provisions for repairs, maintenance and replacement of physical plant and equipment; and

A review of the risk management process or system in place (by both Center Board and Management).

The Consultant will commence work in Cotonou around March 26, 2007 in conjunction with the visit by the ARC-WARDA Review Panel. He/she will work closely with and report directly to the panel member with overall responsibility for reviewing Center governance/ management/finance aspects, and submit a written report that summarizes the findings and any recommendations, in an agreed format, by April 15, 2007.



**ANNEX III**  
**Strategic Issues for the 5th Africa Rice Center EPMR**

1. What is the quality of WARDA science?
2. Does WARDA have the critical mass to extend reach of activities into east and southern Africa (ESA)? What will be the opportunity cost to research for the WACA region? As IRRI is engaged in ESA also, what are the respective comparative advantages of the two centres in this region?
3. Does WARDA have the right research balance among the rice ecosystem in Africa? Where is the most potential for impact? What should be WARDA's research on cropping systems of the inland valleys where the great productivity potential remains untapped? Is WARDA's research on irrigated rice appropriate to the policy environment of Africa?
4. To what degree has WARDA assessed the constraints to the adoption of NERICAs (and technical and institutional action needed to address these constraints)?
5. Is WARDA facilitating the maximum gene discovery and mining from the African rices through collaboration, particularly in molecular science? How well is the capacity building program at WARDA set-up, not only for uptake of crop genomics, but for imparting such technology to collaborating universities in SSA? Are there notable research contributions to rice comparative genomics/proteomics from studies on NERICA rices? Is there a well-articulated plan to build a bioinformatics platform for rice and other cereal crops West Africa?
6. Does WARDA have a "business plan" to use molecular information for routine screening?
7. Does WARDA's INRM research have a strategic foundation, and clear issues identified where the Center can add value that has more than just local relevance? Has a clear impact pathway been developed?
8. Is WARDA taking full advantage of IITA's expertise and critical mass in IPM? Is WARDA's 'recommendations' approach in both IPM and in soil management appropriate, or should this be the job of NARS? What is the progress on weed management as a major limiting factor to improving labour productivity?
9. In the partnership with AVRDC and others for diversifying rice-based production systems with livestock, fish and vegetables, is the work carefully focused, so that it does not dilute WARDA's efforts, and is it supported by appropriate socioeconomic research? Does WARDA have a clear rationale for its involvement in the diversification and move in this direction?
10. In its partnership with IRRI, is WARDA capturing the "non-African" specific products and knowledge from the improvement of upland, rainfed and irrigated rice, especially since this is critical for such constraints as drought and, perhaps, nutritional enhancement, which are generic to all continents?
11. Is WARDA taking full advantage of potential for collaboration with the Harvest Plus CP, for example on genetic engineering activities related to Golden Rice in West Africa?
12. To what degree is WARDA's research focused on the Center's comparative advantage and generation of IPGs, particularly in the Consortium for the Sustainable Development of Inland

Valley Agro-Ecosystems in Sub-Saharan Africa (IVC), the Systemwide Initiative on HIV/AIDS and Agriculture (SWIHA), and Project 6 on Climate Change modeling?

13. Should WARDA continue Project 4 on Integrated Management of Drought in Rainfed Rice Ecosystems in Africa as a separate effort from Projects 1 and 2 on upland and lowland rice production systems, respectively, given that Project 4 is conceptually orthogonal to both projects, which aim to enhance and sustain productivity in rainfed rice?
14. Availability of good quality seed is a bottleneck in taking the fruits of WARDA's research to farmers. How effectively is WARDA collaborating with NGOs, farmer organizations and the private sector to promote the development of 'seed systems' designed to enhance the delivery of promising NERICA lines?
15. What should be the focus of further progress of the WARDA-IITA alignment process? What should be WARDA's alignment process with the WCA, ESA and SSA CP MTPs?
16. Is a strong case for compliance of member state funding commitments being made effectively, and on the basis of country-specific impact assessment? WARDA has had the highest indirect cost ratio among the CGIAR Centers during the past several years. What measures could the Center take to address this issue?
17. Does WARDA have an appropriate plan of action regarding infrastructure and installations left behind in Ivory Coast? What further steps should WARDA take regarding its planned return to the Ivory Coast?
18. Has WARDA enabled the establishment of an efficient and transparent system of financial management of partnerships? For example, what actions if any should WARDA take to solve Phase II of the Inland Valley Consortium project's problems regarding financial management and cash flow problems, both at the level of WARDA and the Regional Coordinating Unit (RCU) host institutes?

## ANNEX IV

### Itinerary of the EPMR Panel (Schedule of the Initial and Main Phases, and Field Visits)

19-23 March	<b>Initial contact with BoT: Panel</b> Chair and G&M Panel member, in WARDA headquarters in Cotonou.
24 March- 30 March	<b>Field visits:</b> Chair visited Ivory Coast WARDA HQ Station at M'bé, discussed with the CNRA dg and the Ivorian authorities. Chair visited WARDA's Council of Ministers president, the Federal Minister of Agriculture and Water Resources in Abuja, the Agricultural Research Council, the World Bank office in Abuja, the executive director of the National Cereals Research Institute who is chairman of NEC, and discussed WARDA's operations in Nigeria
2-6 April 2007	<b>Initial phase:</b> Entire Panel, plus the two Panel consultants (Finance—Mary Ncube, and Rice Physiology—Toshihiro Hasegawa) plus the Panel secretary, visited WARDA headquarters in Cotonou, Benin. Visit consisted mainly of Program Presentations by the Panel and initial interviews with staff.
11-15 June 2007	<b>Field visits:</b> Eric Tollens and Zelia Menete, Uganda
24-30 June 2007	<b>Field visits:</b> Eric Tollens, Zelia Menete, Brigitte Courtois, visited WARDA's operations in Senegal, Mali, and Mauritania.
9-21 July 2007	<b>Main Phase:</b> entire Panel, plus Panel Secretary visited WARDA headquarters in Cotonou, Benin.

**ANNEX V**  
**People Contacted/Interviewed by the Panel**

**WARDA regional staff**

Dr. Vincent Bado, St. Louis Station Chief, Senegal

Dr. Ajayi Olupomi, Coordinator WARDA Nigeria at IITA, Ibadan

Dr. Ashura Luzi-Kihupi, Regional coordinator ECARRN for ASARECA, Tanzania

Dr. Sitapha Diatta, WARDA representative in Côte d'Ivoire

**Advanced Research Institutions**

Bruno LIDON, UMR GEDO, Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France

Dr. Alain Ghesquiere, Geneticist and Research Director, Institut de Recherches pour le Développement (IRD), France

Dr. Tim Chancellor, Head - Plant, Animal and Human Health Group, Natural Resources Institute, University of Greenwich at Medway, UK

Susan McCouch, Associate Professor, Plant Breeding and Plant Biology, Cornell University, USA

Dr. May-Guri Saethre, Bioforsk, Norwegian Institute for Agricultural Environmental research, As, Norway

**Development Organizations and NGOs**

Kayaayo Battson, Program Director, Sasakawa Global 2000, Uganda

Akande, Samuel Oyetunji, Professor of Agricultural Economics, Nigerian Institute of Social and Economic Research (NISER), Nigeria

Dr. Takashi Kumashiro, Director, Biological Resources Division, Japan International Research Center for Agricultural Sciences (JIRCAS), Japan

Mrs. Peinda Gueye Cissé, FEPRODES, Senegal

Dr. Tareke Berhe, Director Rice Program, SAA/SG2000, Addis Ababa, Ethiopia

Yacouba Coulibaly, Nyeta Conseils, Nioni, Mali

Idrissa Diawarra, directeur général adjoint, Office du Niger, Ségou, Mali

Moussa Kané, Centre de recherche, Office du Niger, Ségou, Mali

Salif Diarra, directeur général OMA, Bamako, Mali

Seiny Ndao, directeur du développement rural, SAED, St. Louis, Senegal

Sarr Malick, directeur général adjoint, SAED, St. Louis, Senegal

Le directeur regional du SONADER Trarza, Rosso, Mauritania

Breun Gouyor, president cooperative Trarza, Rosso, Mauritania

Ahmed Ould Bah, directeur général SONADER, Nouakchott, Mauritania

Diop, responsable de la mise en valeur, SONADER, Nouakchott, Mauritania

**Donor**

Marc Debois, Directorate General Development Unit DEV/B/4: Environment and Rural Development, Directorate General Development EU, Belgium

Helene Corneau, Director, United Nations and Commonwealth Division, Canada

Dr. Kanayo Nwanze, Vice-president IFAD, Rome

Cheikh Sourang, Senior Programme Manager, IFAD, Rome

Mr. Mohammed Béagovui, directeur PA division (WCA), IFAD, Rome

Dr. Akin Adesina, Rockefeller Foundation, Nairobi

Dr. Peter Matlon, Rockefeller Foundation, Nairobi

Mr. Robert Kargbo, Senior Agricultural Advisor, USAID/WARP, Ghana

Robert. Anyang, USAID/APEP, Uganda

Cllice Drew, USAID/APEP, Uganda

David Kamukama, manager SME Agribusiness, USAID/APEP, Uganda

Jaap Blom, Agribusiness Development Component, Agricultural Sector Programme Support, Danida, Kampala, uganda

Mr. Yoshio HORIUCHI and Mr. Mitsutaka UCHIJIMA, Regional Chief Representatives, Ouagadougou, Burkina Faso, JICA, Japan

Dr. J. Devries, Rockefeller Foundation, Nairobi

Dr. Simon Ehui, Lead economist, The World Bank, Abuja

Ms. Marjorie Meis, Programme Manager, Associate Expert Programme (DSI/MY), Ministry of Foreign Affairs, The Netherlands

Ruth Haug, Director, Agricultural University of Norway, Norway

Dr. Staffan Wikteliuss, Senior Research Advisor, Swedish International Development Cooperation Agency, Sweden

Thomas Lumpkin, Director General, AVRDC, Taiwan

Roy Metherell, Central Research Department - Department for International Dev., UK

Eija Pehu, Advisor, Agric. and Rural Dev. Department (ARD) The World Bank, USA

**National Agricultural Research Institutes**

Monsieur le Directeur, Institut de l'Environnement et des Recherches Agricoles (INERA), Burkina Faso

Monsieur le Directeur Général, Institut Centrafricain de Recherche Agronomique ICRA, Central African Republic

Dr. Adama Traore, secrétaire exécutif SNRA, Comité National de la recherche Agricole, Bamako, Mali

Dr David Arodokoun, Directeur Général, Institut National de Recherches Agronomiques du Bénin (INRAB), Bénin

Dr. Djegui Narcisse, Directeur Général INRAB, Bénin

Alavo Antonin, Coordonnateur programme d'appui au développement des filières agricoles, Bénin

Youssouf Dembele, Chef Programme Riz, INERA - Farako-bâ, Burkina Faso

Prof. Gnissa Konaté, Director, Institut de l'Environnement & des Recherches Agricoles (INERA), Burkina Faso

Julius Takow, Chief of Station, IRAD-Barombi-Kang, Cameroun

Monsieur le Directeur Général, Institut de Recherche Agricole pour le Développement (IRAD), Cameroun

Dr Namba Yallah, Directeur Général, Institut Tchadien de Recherche Agronomique (ITRAD), Chad

Wongbé A. Yté, Head of Program, CNRA, Cote d'Ivoire

Dr. Yo Tiémoko, Directeur Général, Centre National de Recherche Agronomique (CNRA), Côte d'Ivoire

Mr Joseph B. Mateso, Chief of National Rice Research Programme, INERA, Kshasa, DRC

Dr Getachew D. Alemayehu, Director General, Amhara Regional Agricultural Research Institute (ARARI), Ethiopia

Dr Musa Bojang, Director General, National Agricultural Research Institute (NARI), Gambia

Ansumana Gibba, Research Officer, NARI, Gambia

Dr Sékou Béavogui, Directeur Général, Institut de Recherche Agronomique de Guinée (IRAG) Guinea

Baourou Mansaré, Agronomist, IRAG, Guinea

Dr Simao, Président Instituto Nacional de Pesquisa Agraria (INPA), Guinea Bissau

Dr G. Simao, Président/Chairman, Instituto Nacional de Pesquisa Agraria (INIPA), Guinea Bissau

Ebenezer Annan-Afful, Research Officer, CSIR-CRI, Ghana

Dr. Emmanuel Owusu-Bennoah, Director General, Council for Scientific & Industrial Research (CSIR), Ghana

Mrs Winfred A. O. Kore, KARI- KIBOS, Kenya

The Director General, Central Agricultural Research Institute (CARI), Liberia

Dr Rabeson Raymond, FOFIFA Rice Research Department, Madagascar

Abdoulaye Hamadoun, Director CRRA Sikasso, IER, Mali

Dr Bino Témé, Directeur Général, Institut d'Economie Rurale (IER), Mali

Brehima Kamissoko, Seed Production, CRRA, Mali

Jean-Luc, Sanogo, Agronomist, CRRA, Mali

Brenna Guindo, PRI-CRRA, Mali

Lassana Diarra, Researcher rice program, CRRA, Mali

Hamady Sissoko, Chief Accountant, CRRA, Mali

Dr Cheikh Ould Dih, Directeur Général, Centre National de Recherche Agronomique et de Développement Agricole (CNRADA), Mauritania

Ngam Abou Ouman, directeur adjoint, CNRADA, Nouakchott

Dr Mahaman Issaka, Directeur Général, Institut National de Recherches Agronomiques du Niger (INRAN), Niger

Dr. A. A. Ochigbo, Director/Chief Executive, National Cereals Research Institute (NCRI) Badeggi, Nigeria

Oladela Bakare, Research Officer, NCRI-Badeggi, Nigeria

Mr John Jagwe, Post Harvest and Market Research Network of ASARECA, Uganda

Mr Patrice Hakizimana, ISAR-Rubona, Rwanda

Mamadou Khouma, Chef LNRPV, ISRA, Senegal

Dr. Macoumba Diouf, Directeur Général, ISRA, Senegal

Dr. Alioune Fall, ISRA, St. Louis, Senegal

Dr. Souleymane Diallo (weed specialist), ISRA, St. Louis, Senegal

Dr. Madaima Cisse (agronomist), ISRA, St. Louis, Senegal

Dr. Moussa Faye (soil specialist), ISRA, St. Louis, Senegal

Mr. Malick Sarr, Deputy Director General, SAED (irrigation agency), Senegal

Prof. Edward Rhodes, Director, National Agricultural Research Coordinating Council (NARCC)  
Sierra Leone

Mohamed Kandeh, Director, LWDD, Sierra Leone

Dr Evelyne A. Lazaro, Sokoine University of Agriculture, Tanzania

Soklou Worou, Head of Program, ITRA/DG, Togo

Dr Atsu Comlan Agbobli, Directeur Général, Institut Togolais de Recherche Agricole (ITRA), Togo

Godfrey Asea, Breeder Cereals Program, NARO, Uganda

Cyprien Ebony, director of quality assurance, NARO, Uganda

Robert Anguzu, public relations officer, NARO, Uganda

J. Magyembe Mwesigwa, coordinator, competitive fund scheme, NARO, Uganda

Dr. Michael Ugen, acting director, NARO, Namulonge, Uganda

Jimmy Lamo, rice breeder, NARO Namulonge, Uganda

T. Tsuboi, JICA expert on rice, Namulonge, Uganda

Dr. Taïb Diouf, Directeur scientifique, ISRA, Senegal

Prof. B.Y. Abubakar, Executive Secretary, Agricultural research Council of Nigeria, Abuja

Dr. S.A. Ingawa, Director Projects Coordinating Unit, Abuja

Dr. A.A. Ochigbo, Executive Director, National Cereals Research Institute, Badeggi, Nigeria (NEC chair)

**Private Sector**

Babatundé R. Ollofindji, Société Tunde, Cotonou, Bénin

Abdouahmane Malick Ndiaye, directeur Agritec, St. Louis, Senegal

Joel Kibamba, Administrative Assistant, ENI Congo, Democratic Republic of Congo



I.K. Mulindwa, MP Limited, Kampala, uganda

Ambassador Philip Idro, Upland Rice Millers, Jinja, Uganda

Mrs. Susan Mary Muyinga, Procurement, Nsanga Agrochemicals, Ltd. Uganda

Joseph Kavuma, Manager, Tonnet Enterpris, Uganda

Amin Farishta, Production Manager, Sunrue Commodities, Ltd, Uganda

Nicolai Rodeyys, Manager, Naseco (1966) Ltd, Uganda

Cliff-Richard, Masagazi, Marketing Manager, Naseco (1966) Ltd, Uganda

Christian Baine, Director, Corunet Consult, Ltd, Uganda

Frederick Muduuli, Managing Director, Keith Associates Agroinput Dealers, Uganda

B.S. Gowda, General & Allied, Kampala, uganda

Abdallah Byabasaija, Business Development Manager, SOMED, Uganda

Peter Bran, Administration Manager, Upland Rice Millers Co. Ltd., Uganda

Charles Sembatya, Agronomist, Enterprise Dev. Specialist, Sasakawa Global 2000, Uganda

Mubangizi Emmanuel, production manager, Farm Inputs Care Center (FICA), Kampala, Uganda

Justus Imanywoha, breeder, FICA, Kampala, Uganda

Lincoln Lunagga, Makinawa Rice Farm, Uganda

Nelson Ojwiya, General Manager, China Huangpai Foods, Ltd, Uganda

Geoffrey Sebabindiru, Sales Manager, Global Agro-Inputs, Ltd, Uganda

B.N.S. Gowda, Director, General Allied Ltd., Uganda

#### **Sub-Regional Organizations**

Dr Seyfu Ketema, Executive Secretary, ASARECA, Uganda

Fina Opio, program coordinator staple crops, ASARECA

Dr. Marcel Nwalozi, Scientific Coordinator, CORAF/WECARD, Senegal

IVC President, INRAB, Bénin

#### **Universities**

Prof. Dayun Tao, Deputy Dir. General, Crops Res. Inst., Yunnan Academy of Agricultural Sciences, China

Prof. Dr. Matthias von Oppen, Agricultural Economist, Hohenheim University, Germany

Prof. Ryuichi Ishii, University of Nihon, Japan

Prof. Tatsuhiko Shiraiwa, Crop Science Lab. Graduate School of Agric., Kyoto Univ., University of Kyoto, Japan

Pieter Windmeijer, Executive Secretary, North - South Center, Wageningen University and Research Center (WUR), Netherlands

**CGIAR**

Laura German, A&H

Ruth Meinzen-Dick, CAPRI

Victoria Henson-Apollonio, CGIAR CAS-IP System Unit of the CGIAR

Joachim Voss, Director General, CIAT

Douglas Pachico, DDG-Research, CIAT

Jean-Marcel Ribaut, Director, Generation Challenge Programme

Dr. Howarth Bouis, Director, Harvest Plus Challenge Programme

Enrica Porcari, ICT-KM System Unit of the CGIAR

Joachim von Braun, Director General, IFPRI

Mark Rosegrant, DDG Research, IFPRI

Peter Hartman, Director General, IITA

Paula Bramel, DDG Research, IITA

Carlos Sere, Director General, ILRI

John McDermott, DDG-Research, ILRI

Robert Zeigler, Director General, IRRI

Ren Wang, DDG-R (at the time he was contacted), IRRI

Paul Kiepe, IVC (convened by WARDA)

Frank Rijsberman, ex- Director General, IWMI

David Molden, DDG-Research, IWMI

Salvador Fernandez-Rivera, Livestock Program (SLP) SWP

Barun Gurung, PRGA SWP

Olaf Erenstein, RWC Rice-Wheat Consortium for the Indo-Gangetic Plains

Braima James, SP-IPM Systemwide Program on Integrated Pest Management (SP-IPM)

Freddie Kwesiga, Programme Coordinator (at the time he was contacted), Sub-Saharan Africa Challenge Programme

Ann Marie Kormawa, SWIHA (convened by WARDA)

Toby Hodgkin, System-wide Genetic Resources Programme

Cliff Mutero, Systemwide Initiative on Malaria and Agriculture (SIMA)

Jonathan Woolley, Water and Food Challenge Programme

Pamela George, Program Manager, Water and Food Challenge Programme

Stephen Hall, World Fish Center

Patrick Dugan, DDG-Research, World Fish Center

**Ministers/Political authorities and their representatives**

Mallam Adamu Bello, Hon. Minister of Agriculture and Water resources (COM President), Abuja

Dovonou Roger, Hon. Minister of Agriculture, Livestock and Fisheries, Cotonou, Bénin

Hibault Alexio, directeur de cabinet, Ministre de l'Enseignement Supérieur et de la Recherche, Abidjan, Côte d'Ivoire

Okaasai S. Opolot, Commissioner, Crop Production and Marketing, Ministry of Agriculture, animal Industries and Fisheries, entebbe, Uganda

Vincent K. Musubire, Deputy Principal Secretary, Office of the Vice-President, Uganda

**ANNEX VI**  
**List of documents reviewed by the Panel**

1. Terms of Reference and Guidelines for External Program and Management Reviews of CGIAR Centers
2. Most recent EPMR report of the Center
3. Summary of actions taken in response to the last EPMR
4. CGIAR research Priorities 2005-2015
5. The latest Board-approved Strategic Plan of the Center
6. Medium-Term Plans of the Center for the period of review
  - SSA Regional MTP 2007-2009
  - WCA Regional MTP 2007-2009
  - MTP 2007-2009
  - MTP 2006-2008
  - MTP 2005-2007
  - MTP 2004-2006
  - MTP 2003-2005
  - MTP 2001-2002
  - WCA MTP: Consultative and Coordination Meeting 6-8 Nov 06, Summary Report and Meeting Report
7. SC commentaries of the Center's Medium-Term Plans
  - 2006 SC MTP 2007-2009 Commentaries and Center Response
  - 2005 SC MTP 2006-2008 Commentaries and Center Response plus SC overview
  - 2004 SC MTP 2005-2007 Commentaries and Center Response
  - 2003 SC MTP 2004-2006 Commentaries and Center Response
  - 2002 SC MTP 2003-2005 Commentaries and Center Response
  - 2000 SC Financing Plan 2001
8. Center-Commissioned External Review Reports
  - Integrated Genetic and Natural Resources (IGNRM) plus Actions Update from Feb07
  - Partnerships (A B Obilana, H. Feyt, M. N Kaporiri) plus Actions Update from Feb07
  - Inland Valley Consortium (IVC) (E. Smaling, J. Payen, F. Lompo)
  - Organization and Management: Post crisis team building (D. Koudou, R. Kuyo)
  - Social Science Research Agenda (Prof. M. von Oppen, (Chair), Prof. Shabd S. Acharya, and Prof. E. M. Koffi-Tessio) plus Actions Update from Feb07
9. Donor commissioned external review reports
  - European Union - "Policy environment & rice market development" (EU Proj 3.2) plus Centre Response
  - UNDP - Africa-Asia Joint Research: Interspecific Hybridization between African and Asian rice species
  - Gatsby and Rockefeller Foundation – "Evaluation of adoption of NERICA and other improved upland rice varieties following varietal promotion activities in Nigeria"
  - USAID - Evaluation of the USAID-Funded Collaborative Agricultural Research Networks in West and Central Africa
  - EU Review\_ Creating Low Mngnt Plant Types for Resource Poor Farmers in Rainfed Ecosystems (Proj 1.4)
  - EU Review\_SSA Challenge Programme. Review of the inception phase.
  - BMZ\_Proj Review on farmer participatory improvement and adaptation of production technologies for rainfed rice-based systems in W Africa with emphasis on Nigeria and Benin

10. List of achievements/outputs by Program or other research unit: publications (peer-review and other), research breakthroughs as recognized by peers, germplasm, genetic stocks, new technologies etc.
11. A paper prepared by Center management and Board on: a) main issues of current concern, b) vision of clients needs in intermediate (5 years) and long (10 years) term; c) vision on CGIAR and donor status in intermediate and long term; d) state of the relevant science in intermediate and long term; e) plan of action reflecting these vision statements
12. The current organization chart, with a brief description of the Center's internal management structure, including the composition and terms of reference of each major committee
13. Toward a New Vision and Strategy for the CGIAR
14. New Monitoring and Evaluation System for the CGIAR Centers
  - New Monitoring and Evaluation System for the CGIAR Centres
  - Comments from Science Council on Performance Monitoring Indicators - Pilot Year 2005
  - SC Suggestions to Implement the CGIAR Performance Measurement System
  - SC feedback on PM Results – Africa Rice Center (WARDA)
15. EPMR reports of CGIAR Centers
16. Most recent CGIAR stripe studies involving the Center
  - Stripe Review of Corporate Governance of CGIAR Centers
  - Criteria for Assessing Proposals for new Systemwide Programs
  - Status of Monitoring and Evaluation of CGIAR Systemwide and Ecoregional Programmes
  - Report of the First External Review of the Systemwide Programme on Integrated Pest Management (SP-IPM)
  - Lessons Learned in the Implementation of Systemwide Programmes - iSC Perspectives - 2002
  - Systemwide Review of Plant Breeding Methodologies in the CGIAR
  - Systemwide Review of Plant Breeding Methodologies in the CGIAR WARDA's sub-Panel report
17. The CGIAR Charter
18. Most recent Annual Report of the Center, and comparable research reports of the programs
  - Forward in Partnership: Annual Report 2004-2005
  - Africa Rice Centre: Program Report 2002-2003
19. The latest Annual Funding Request
20. List of professional staff with short CVs including standard set of information as instructed by the SC Secretariat (publications, key memberships, invited lectures, prizes/awards, students supervised)
21. List of reports of major planning conferences, internal reviews, expert meetings, etc., which have had a major influence on the direction of specific Center programs
22. List of the agreements for cooperative activities with other Centers and institutions
23. List of ongoing and recently completed contracted projects
24. Most recent CGIAR financial guidelines and manuals
25. Reference Guides for CGIAR International Agricultural Research Centers and their Boards of Trustees
26. Center Charter and other basic documents establishing the Center, along with subsequent amendments
27. Table showing composition of the Board over the last five years, along with an indication of the term of office of current members and their roles on the Board
28. Board handbook or rules of procedure
29. Table showing allowances, benefits, and salary ranges for each category of staff

30. Table showing personal data on professional staff by program, including each job title, incumbent's location, IRS/NRS/LRS status, period of tenure, gender, nationality, age, salary over the last three years, funding source (excluding names)
31. Table summarizing turnover of staff over the last five years by staff category
32. List of international staff vacancies and how long positions have been vacant
33. Set of minutes covering Board and Board committee meetings since the last External Review (and reports of board committees to the full Board if not included in the minutes)
34. Staff manual or a description of current personnel procedures for international and locally-recruited staff
35. Local compensation surveys used by the Center
36. Reports of external auditors, including management letters, and financial officer's reports to the Board since the last External Review
37. Most recent internal audit reports
38. Executive Council of the CGIAR Meeting Documents
  - ExCo10 (Tenth Meeting of the Executive Council); Summary Record of Proceedings, CGIAR Alignments in SSA and Beyond: AGM05 Decisions on SSA Task Forces Follow-up, Response to main decisions/conclusions on WCA arrangements: SSA Task Forces follow-up (Joint IITA/WARDA Report to ExCo 10); IITA - WARDA Alignment - Agreed deliverables
  - ExCo9 (Ninth Meeting of the Executive Council); Summary Record of Proceedings, SSA TF Follow ups: IITA WARDA Discussions, Progress on dev of sub-regional MTPs Update, Progress on dev of regional MTPs, CGIAR global Centres in Africa 2005
  - ExCo8 Eighth Meeting of the Executive Council); Summary Record of Proceedings, SSA TF on Prog and Structural/Org Alignment: Rpt of the CGIAR SSA TF, ExCo Members' Corrections/Comments on the draft SSA TF rpt, Rpt of the CGIAR SSA TF presentation
39. CGIAR ICW 2000 Proceedings Decisions
40. Impact Case Studies
  - Dalton, T & Guei R.\_Productivity Gains from Rice Genetic Enhancements in W Africa: Countries and Ecologies (World Development 33(2):359-374)
  - Diagne\_The Diffusion and Adoption of NERICA rice varieties in Côte d'Ivoire (Developing Economies 44:(2))
  - Patrice Y. Adegbola, 1, Aminou Arouna, Aliou Diagne et Souléïmane A. Adekambi. Determinants Socio-Economiques et Taux d'adoption et d'intensité d'adoption des nouvelles variétés de riz Nerica au centre du Bénin (Adoption NERICA\_Benin\_7\_sup)
  - Aliou Diagne. Taking a New Look at Empirical Models of Adoption: Average Treatment Effect Estimation of Adoption Rates and their Determinants\* (Diagne Paper IAAE 2006 October 2006\_with tables)
  - Barry M.B, Diagne A, Sogbossi M.J, Pham J.L, Diawara S, Ahmadi N.Recent changes in varietal diversity of rice in Guinea. (Guinee Biodiv Article VERSIONNovembre\_aliou edit)
  - Souléïmane A. Adekambi, Aliou diagne et Gauthier Biaou. Impact de l'adoption DES variétés Nericas sur la scolarisation des ENFANTS AU Bénin : cas du département des collines (Impact Nerica scolarité enfants Bénin\_v1)
  - Patrice Y. Adegbolaa, 1, Aminou arouna, Aliou diagne et Souléïmane A. Adekambia. Evaluation de l'impact économique des nouvelles VARIÉTÉS de riz nerica au Bénin : Une évidence avec les modèles basés sur l'approche « Contre factuel » (Impact Nerica\_Benin\_6)
  - Aliou Diagne ; Marie-Josée Sogbossi ; Sékou Diawara ; Abdoulaye Sadio Diallo et Alpha Bacar Barry. Evaluation de la diffusion et de l'adoption des variétés de riz NERICA en Guinée (Nerica adoption et diffusion Guinée sep06\_aliou edit)

- Aliou Diagne. Diffusion and adoption of Nerica rice varieties in Côte D’Ivoire (The Developing Economies, XLIV-2 (June 2006): 208–31)
  - A. Diagne; M. J. Sogbossi; I. Touré et A. Camara. How Successful has been the Dissemination of the NERICAs rice varieties in Guinea? Country- level areas estimation from household survey and census data (Nerica Dessimination Guinee Fevrier 06)
  - Dunstan Spencer, Andrew Dorward, George Abalu, Dayo Philip and Diji Ogungbile. Evaluation of adoption of Nerica and other improved upland rice varieties following varietal promotion activities in Nigeria (Nerica\_Report\_RevAndrew-DS-April 7-2006)
  - Aliou Diagne. Assessing the Impact of Agricultural Research Using the Counterfactual Outcomes Framework: The WARDA experience (WARDA Impact of Ag Research IAAE 2006)
  - Aliou Diagne. Bred for Women Rice Farmers? Impact of Nerica Adoption on Rice Yield in Côte d’Ivoire. (Yield Impact Nerica\_Exp Ag\_ v1-December 2006)
  - NERICA Adoption and Impact: Papers and Abstracts
41. IRRI Relevant Documents
- IRRI Strategic Plan 2007-2015
  - Bringing Hope, Improving Lives: Why Rice Research is Important for Poor People (presentation by R. Ziegler, June 2005)
42. Sub-Saharan Africa Challenge Programme
- SSA CP Full Proposal: Building Sustainable Livelihoods Through Integrated Agricultural Research for Development - Main text & Annexes
  - SC Commentary on the SSA Challenge Programme Proposal
  - EU Review\_ SSA CP Inception Phase
  - SSA CP external review
43. SWEP - Consortium for the Sustainable Use of Inland Valley Agro-Ecosystems in Sub-Saharan Africa, commonly referred to as the Inland Valley Consortium (IVC)
- SWEP\_IVC extract from MTP 2007-2009 submission
  - SWEP\_IVC extract from SC Commentary MTP 2007-2009
44. SWEP - Systemwide Initiative on HIV/AIDS and Agriculture (SWIHA)
- SWIHA\_Review Progress report
  - SWIHA\_Project planning workshop report\_Building resilience to HIV/AIDS among smallholder farmers in Benue state, Nigeria
  - SWIHA extract from MTP 2007-2009 submission
  - SWIHA extract from SC Commentary of MTP 2007-2009
  - SWIHA\_Synthesis report of regional workshop
45. WARDA's recent strategic presentations
- WARDA DG at SC05 ppt: Towards Africa's Rainbow Revolution An Innovative Partnership-Owned R4D System, Kanayo F. Nwanze
  - WARDA DG at SC05 MSWord: Towards Africa's Rainbow Revolution An Innovative Partnership-Owned R4D System, Kanayo F. Nwanze
46. Africa Rice Congress Abstracts\_Beyond the First Generation NERICAs in Africa: Paradigms and Partnerships for the Next Decade
47. Awards
- 2006 -- Le prix du président du Burkina Faso à Dr Moussa Sié et ses partenaires
  - 2006 -- WARDA Wins UN Award
  - Africa Rice Center (WARDA) Wins 2006 South-South Partnership Award
  - 2006 -- Africa Rice Center won the 2nd prize and the “honorable mention” in the First CGIAR International Photo Competition of research and research-related themes
  - 2006 -- The CGIAR Science Award for Outstanding Partnership to the CGIAR Genebank Community
  - 2006 -- WARDA Scientist Wins International Rice Prize from Japan

- 2004 -- WARDA Hails Dr Monty Jones, Co-winner of the 2004 World Food Prize
- 2003 -- Senegal's Presidential Award in 2003
- 48. Financial Information from CGIAR Secretariat
  - Financial Notes on WARDA
  - Financial Notes on CGIAR
- 49. List of WARDA publications since the last review
- 50. Handing-Over Report, Kanayo F. Nwanze, WARDA DG, Dec1996-Nov2006
- 51. List of IRS staff for review in 2007 and 2006

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## ANNEX VII

### 4th WARDA EPMR Recommendations: WARDA's Response and Panel Comments

In general, WARDA has responded well to the recommendations of the 4<sup>th</sup> EPMR and most recommendations have been fully implemented.

*Recommendation 1: The Panel recommends that WARDA strengthen its capacity to monitor and assess the impact of its activities*

**WARDA's 2000 Response:** WARDA agrees that impact assessment is a priority at a time when promising technologies developed and tested during the last decade are reaching farmers' fields. Fully aware of the strategic importance of impact assessment in the forthcoming years, in 1997 WARDA set up two projects in the Policy Support Program which focus on impact assessment of new technologies. A series of impact assessment activities has been planned and funds will be secured for their implementation. WARDA will allocate a full-time position to impact assessment activities as soon as possible.

**WARDA's 2007 Updated Response:** Aware of the strategic importance of impact assessment, in 1997, WARDA set up two projects in the Policy Support Program which focused on impact assessment of new technologies. A series of impact assessment activities were then planned and funds were secured for their implementation. Following the fourth EPMR, WARDA recruited an international staff at the Principal Staff (PS) level in the area of impact assessment. This led to the creation of an impact assessment unit with the following achievements:

#### **Panel's Comments:**

A certain number of impact assessment studies were conducted and papers published in refereed journals. Training and NARS capacity building in IA were done in nine countries of WA. WARDA is strongly involved in SPIA. There is also the need to monitor the impact of adoption of NRM management practices, and to monitor the impact of use of other WARDA's products (databases, etc.).

*Recommendation 2: The Panel recommends that research on crop and resource management for rainfed rice receives a higher priority than at present.*

**WARDA's 2000 Response:** WARDA appreciates this recommendation, as it strengthens its views expressed in the current MTP (p.18), where it is stated "that upland rice research will continue to be oriented more towards conservation and enhancement of the resource base while additional resources have been allocated towards the development of technologies to intensify cultivation in the lowland rice ecosystems. Both ecosystems need to benefit from stronger integrated natural resources management research which will receive greater emphasis during the 2000-2002 MTP period." Crop and natural resources management currently comprises one third of the approved staff plan for 2000-2002, i.e. a similar resources allocation level as for varietal improvement, and is being addressed in a balanced approach. It is essential that a critical mass for both crop/resource management and varietal improvement be maintained if the potential gains are to be realized. The balance between research on crop and resource management and on varietal improvement will be annually reviewed in WARDA's planning.

**WARDA's 2007 Updated Response:** WARDA expressed its appreciation for this recommendation which was in line with the 2000-2002 MTP. Crop and natural resources management currently comprises about one third of the approved staff plan for 2007-2009, i.e. a similar resources allocation level as for varietal improvement, and is being addressed in a balanced approach. It is essential that a

critical mass for both crop/resource management and varietal improvement be maintained if the potential gains are to be realized. Since year 2000, the balance between research on crop management and on varietal improvement has been annually reviewed during the planning week. A CCER on Integrated Genetic and Natural Resource Management (IGNRM) was conducted in 2005-2006, which confirmed WARDA's position.

**Panel's Comments:**

Recommendation fully implemented.

*Recommendation 3: The Panel recommends that research on rainfed rice be consolidated along crop improvement and crop and resource management lines.*

**WARDA's 2000 Response:** WARDA appreciates the thinking underlying this recommendation. In the past, research areas were organized along disciplinary lines. However, these were reorganized in 1997 into integrated projects targeted at defined sets of constraints and ecosystems, resulting in strong interdisciplinary research teams. We believe that consolidating research on rainfed rice, strictly along crop improvement and crop/resource management lines, will be counterproductive. The research strategies, particularly in the integrated projects, are aimed at both genetic enhancement and technologies for sustainable production and improved natural resources management. While WARDA will continue with integrated approaches to technology development, we will ensure that crop improvement and resource and crop management activities become more visible than at present.

**WARDA's 2007 Updated Response:** In the past, research areas were organized along disciplinary lines. However, these were reorganized in 1997 into integrated projects targeted at defined sets of constraints and ecosystems, resulting in strong interdisciplinary research teams. WARDA believes that consolidating research on rainfed rice, strictly along crop improvement and crop/resource management lines will be counter-productive. The 2003-2012 Strategic Plan is the current document which provides the basis for the new program structure along two core areas and research challenges: integrated productions systems, and rice policy and development. It should be noted that WARDA continues to ensure that crop improvement and resource and crop management activities are visible within the two-program structure.

**Panel's Comments:**

Recommendation implemented in part. Work is concentrated on breeding. There should be a better balance with agronomy and NRM. For example, since 2001, WARDA does not have a senior water management scientist.

*Recommendation 4: The Panel recommends an expansion of the Irrigated Rice Programme so as to address effectively irrigated systems beyond the Sahel with emphasis on breeding for the humid and sub-humid zone, and crop and natural resource management.*

**WARDA's 2000 Response:** WARDA welcomes the Panel's support for an expansion of the Irrigated Rice Programme. In 1997, the Sahel Irrigated Rice Programme was expanded to become the Irrigated Rice Programme, in order to address irrigated systems in all agro-ecological zones in the region. Provision has been made for a modest expansion in this programme.

**WARDA's 2007 Updated Response:** WARDA welcomed the Panel's support for an expansion of the Irrigated Rice Program. Irrigated rice systems constitute an important of WARDA agenda beyond the Sahel. Interactions of the Sahel Station have been strengthened with IVC and lowland project. The Strategic Plan 2003-2012 takes into account the expansion of activities related to irrigated rice systems, which is further amplified by the expansion of the geographical mandate into East Africa, including

strong partnerships with ASARECA and NARO. Policy research and support for example is not limited to the Sahel, but include a wide range of activities related to irrigated systems and lowlands.

**Panel's Comments:**

Although WARDA has put emphasis on breeding and NRM for the lowlands with partial or full water control, there is an issue of critical mass at the St. Louis station in Senegal for the irrigated Sahel, particularly in NRM and G X E interaction. This is further explored in the section on rice agronomy and NRM.

*Recommendation 5: The Panel recommends involvement of a full-time senior economist in the Irrigated Rice Program. In addition to giving direction on cost of sustainable production and resource use efficiency, the program should guide the rice production perspective to the household and community level.*

**WARDA's 2000 Response:** WARDA fully agrees that it is now timely to involve a full-time senior economist in the Irrigated Rice Programme. From 1992 until now, two successive post-docs and a visiting scientist have filled the position of economist in the Irrigated Rice Programme for a total period of 5.5 person years. WARDA's MTP for 2000-2002 includes the provision for a postdoc production economist in this Programme. Subject to availability of funding, WARDA management will explore ways of providing the staff continuity that the Programme now deserves, so as to allow the Programme to address the issues highlighted in the recommendation in a consistent and productive manner.

**WARDA's 2007 Updated Response:** During the period of 1992-2003, two successive post-docs, a visiting scientist, then another post-doc, filled the position of production economist in the Irrigated Rice Program for a total period of 8.5 person years. The position has since been converted into a full senior staff position. A CCER in social science conducted in 2006 recommended an increased number of economists. USAID recently approved a project aimed at documenting costs of production of rice in Africa.

**Panel's Comments:**

Recommendation has been fully implemented.

*Recommendation 6: The Panel recommends that the Policy Support Program develops a strategic and more coherent agenda so as to address issues of food security, post-harvest opportunities, sectorial policy and seed marketing. WARDA should pursue more pro-active research collaboration on these issues with regional, other Southern and Northern University partners, particularly through the Task Force mechanism.*

**WARDA's 2000 Response:** WARDA welcomes this recommendation, as it confirms the relevance of the research initiated and planned in the Policy Support Programme as stated in the 2000-2002 MTP. WARDA agrees that the development of a consistent network of partners within and outside the region is required to fully implement and complete the Policy Support Programme agenda. Initial contacts have been made with regional and international research institutions to identify areas of collaboration in the policy domain, and to strengthen the collaboration, including the development of formal collaboration agreements with Universities in the region.

**WARDA's 2007 Updated Response:** WARDA welcomed this recommendation at the time of the fourth EPMP and agreed that the development of a consistent network of partners within and outside the region was required to fully implement and complete the Policy Support Program agenda. Initial contacts were made with regional and international research institutions to identify areas of

collaboration in the policy domain, and to strengthen the collaboration, including the development of formal collaboration agreements with Universities in the region. In 2001, a workshop was organized which brought together WARDA and universities in Africa together. Follow up actions were defined and are being pursued. A research plan paying particular attention to the points raised in the EPMR was developed in 2004. This document formed the basis for developing Project 5 of the 2005-2007 MTP. A number of actions have been taken to strength policy support agenda and strategy:

A study on Nigeria rice economy funded by USAID has been completed; follow up actions are been undertaken

A workshop on policy bringing together stakeholders and practitioners was held

An Agricultural Policy Research and Advocacy Group (APRAG) was created and is functioning

Post-harvest has been clearly highlighted in the 2007-2009 MTP; this is also highlighted in the USAID review of WARP

**Panel's Comments:**

The Policy Support Program still needs considerable improvement and a sharper focus. The Program is now even more important than in 2000 and has suffered from staff vacancies not being filled for a long period of time. A monitoring of the Program by an EC mission in 2004 resulted in a very critical report<sup>116</sup>. And the problems mentioned in that report have not been fully resolved.

*Recommendation 7: The Panel recommends that WARDA develops a new strategic agenda on social and institutional constraints to technology adoption and gains a better understanding of existing knowledge systems in the region.*

**WARDA's 2000 Response:** WARDA endorses this recommendation and recognizes the need to strengthen Program 4. Prior to the creation of Program 4, WARDA began work in this area through the RADORT (Research on Accelerated Diffusion of Rice Technologies) project from 1996-1999, in collaboration with Winrock International. Since Program 4 became operational in 1998, further steps have been taken to strengthen the themes highlighted in the recommendation.

**WARDA's 2007 Updated Response:** During the period of 1996-1999, WARDA initiated work in the area of technology transfer through the RADORT (Research on Accelerated Diffusion of Rice Technologies) project funded by IFAD, in collaboration with Winrock International. Within the context of the then Program 4, WARDA strengthened its capacity in technology transfer with the recruitment of a technology transfer specialist and a redefined RADORT now designated PADS (Participatory Adaptive Research and Dissemination of Rice Technologies in West Africa) also funded by IFAD and which is the middle of its second phase. The technology transfer unit is led by a senior scientist. The recent recruitment of a Sociologist has strengthened the unit. PVS is fully implemented in the 17 member countries and is now widely used for dissemination of all new or improved varieties. PLAR was introduced as a participatory approach.

**Panel's Comments:**

WARDA has made efforts to implement this recommendation but the constraints to technology adoption remain very large and are not always well understood. Knowledge gaps remains and also the situation is shifting due to a number of developments. Constraints are also local context specific, depending on agro-ecological and socio-economic conditions.

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<sup>116</sup> Coulter, Jonathan and Bohumil Havrland, Monitoring of project 3.2 (project 5): Policy Environment and Rice Market Development at WARDA, ECART-NATURA, Monitoring of CGIAR-projects co-funded by the European Commission in 2004, November 2005.



**Recommendation 8:** *The Panel recommends that, due to the extension of new “NERICA” upland rice varieties which will lead to loss of indigenous genetic resources, WARDA should intensify the collection and conservation of indigenous upland rice varieties.*

**WARDA’s 2000 Response:** WARDA agrees with this recommendation. In recognition of possible genetic losses, the centre continues to conserve rice genetic variability of all indigenous rice germplasm in sub-Saharan Africa. Almost all countries in the region have been explored for germplasm collection and conservation, except for some isolated remote areas. WARDA will continue to undertake germplasm collection and conservation, including germplasm repatriation to NARS on request, in collaboration with other organizations and programs within and outside the CGIAR, such as IPGRI, SGRP, FAO, NARS and the sub-regional genetic resources networks. The centre recently consolidated its genetic conservation efforts into a Genetics Resources Unit and is in the process of extending the genebank facilities for medium and long-term conservation.

**WARDA’s 2007 Updated Response:** In recognition of possible genetic losses, the center continues to conserve rice genetic variability of all indigenous rice germplasm in sub-Saharan Africa. Almost all countries in the region have been explored for germplasm collection and conservation, except for some isolated remote areas. WARDA will continue to undertake germplasm collection and conservation, including germplasm repatriation to NARS on request, in collaboration with other organizations and programs within and outside the CGIAR, such as IPGRI, SGRP, FAO, NARS and the sub-regional genetic resources networks. In 1999, the center consolidated its genetic conservation efforts into a Genetics Resources Unit. It has, through an inter-center collaborative project funded by the World Bank and additional funding from Japan, extended its genebank facilities for medium and long-term conservation.

**Panel’s Comments:**

Recommendation implemented but more work needs to be done on the collection of local indigenous genetic resources (*O. sativa*, *O. glaberrima* and wild rices) and their characterization.

**Recommendation 9:** *The Panel recommends that WARDA develops a strategy for managing and periodically reviewing its partnerships for greater effectiveness and efficiency.*

**WARDA’s 2000 Response:** Each of WARDA’s diverse partnerships has periodic reviews built into its normal evaluation and monitoring process. WARDA agrees that there is a need to clearly document the Centre’s formal process for the management and review of its partnerships.

**WARDA’s 2007 Updated Response:** As indicated during the 4th EPMR, each of WARDA’s diverse partnerships has periodic reviews built into its normal evaluation and monitoring process. WARDA agreed that there was a need to clearly document the Center’s formal process for the management and review of its partnerships. A CCER on partnerships conducted in 2005 provided the baseline for streamlining the partnership process.

**Panel’s Comments:**

Recommendation fully implemented.

**Recommendation 10:** *The Panel recommends that the Board of Trustees:*

- i. assists the COM in the search process for positions on the WARDA Board;*
- ii. institutes a formal annual evaluation process for each Trustee, including the Board Chair;*
- iii. ensures that the Program Committee plays a more active role in providing guidance and oversight to the Centre in program strategies and priority setting;*

- iv. *pursues avenues to allow Trustees to be better prepared for meetings. Each Trustee should receive the essential meeting documents at least 7 days before the scheduled meetings.*

**WARDA's 2000 Response:**

- i. The Board agrees. The Secretary to the Board makes an annual canvas to the COM. In addition, the Director General, as Secretary to the COM, will explore, on behalf of the Board, more efficient methods of identifying nationals of member states without impinging upon Article VII.2(a) of the WARDA Constitution.
- ii. The Board agrees to review this recommendation and has already discussed suitable means of such assessment. At its meeting in June 2000, the Board will formalize this process through the Nominating Committee. Prior to that meeting, the Chairperson of the NC will continue to consult available material, including that from the CGIAR on evaluation process.
- iii. The Board agrees and will explore with Management how the effectiveness of the PC can be improved so as to enhance Board involvement in setting priorities and Programme strategies.
- iv. The Board agrees and has been assured by Management that documents will be delivered to Board members well in advance of meetings. Additionally, the Board will consider the merit of a "Reading Day" at Bouaké, prior to Board meetings.

**WARDA's 2007 Updated Response:**

- i. A new process was introduced for the search of Board members from the Association, whereby half of the Trustees are identified by the Board and approved by the COM.
- ii. The Board agreed to review this recommendation and in 2005, it designed a new process of individually reviewing Board members, including the Board Chair.
- iii. The meetings of the Program Committee have been structured to include items of oversight ranging from simple review to orientation of the research agenda and outputs.
- iv. Most of the materials are sent to the Board by electronic means at least two weeks before the meetings. In addition, Trustees are provided hard copies on arrival, including materials not sent earlier by e-mail. A reading-day was instituted to assist in better preparing for meetings.

**Panel's Comments:**

The Panel agrees with WARDA's update of 2007; and commends the Board for implementing all but one (item iii above) of the 4<sup>th</sup> EPMR's recommendations on BOT. Regarding item iii, the Panel agrees that the Program Committee now plays a more active role; but it believes that additional efforts are needed to ensure that the PC provides adequate scientific guidance and oversight to the Centre's research program. A recommendation has been made in our report to this effect.

*Recommendation 11: The Panel recommends that Management takes such actions as necessary to capitalize on the strengths and address the weaknesses identified in the Staff Survey, and that the Board replicate the Survey every 18 months to monitor progress and to provide feedback to the Staff, and Management.*

**WARDA's 2000 Response:** WARDA agrees and the Board and Management have taken particular note of this recommendation. As was recorded in the report, WARDA had already taken steps to address staff issues by retaining a Human Resources Specialist of the Organizational Change Program (OCP) to assist Management. A Senior Management Team (SMT) retreat held in September 1999 identified three sets of issues – more consultation for increased transparency and participation, attracting and retaining high caliber staff, and building and sustaining morale – as challenges to be addressed by the SMT over the next 12 months. The SMT comprises members of the Executive Management Committee (EMC), the Programs Management Committee (PMC) and the Administration and Finance Committee (AFC). One of the outcomes of the retreat was the commissioning of a comprehensive, diagnostic staff survey to be conducted by the OCP in mid-2000,

the timing of which will now be reviewed by the Board and Management in the light of the Staff Survey carried out by the Panel.

**WARDA's 2007 Updated Response:** WARDA took note of this recommendation. Staff quality and retention is one of the strategic points being addressed by Management. Increased consultation and transparency in decision-making were key to successfully leading WARDA through the crisis. While no formal staff surveys were undertaken, the annual evaluation process was deemed to provide the necessary information as requested by such surveys. Following the major crises in Cote d'Ivoire in 2002 and 2004, WARDA management treated staff psychology and concerns with the utmost attention. These efforts are documented in a number of sensitive documents. The efforts continue until today. To mention but the most important actions:

In June 2004, after the first crisis in September 2002, with relocations to Bamako and Abidjan, management called on a senior consultant to assess staff morale and concerns in a major team building exercise.

In May and August 2005, after the second crisis of November 2004, and the temporary relocation to Cotonou, management again called on the services of a psychiatrist (MD) to assess the consequences of these traumatic events, at individual, group and institutional levels.

In February 2006, a 2-day retreat was held in Cotonou, involving representatives of all categories of staff. The retreat was very useful and resulted in an action plan which is regularly reviewed by WARDA's Senior Management Team (SMT).

**Panel's Comments:**

The Panel agrees with WARDA's update of 2007 that Management has taken several steps during the past few years to address issues of staff quality and retention, as well as other staff concerns highlighted in the 2004 team building exercise and the 2006 management retreat. It also recognizes that the Ivorian crisis of 2002-2004 had a major impact on staff morale and management of the Center, and that its after-effects are still being felt, though to a lesser degree than in previous years. The staff satisfaction survey conducted by the Panel for the 2007 EPMR has identified continuing concerns, some of which can be traced to the high staff turnover during the past few years, the continuing uncertainty regarding the planned return to Côte d'Ivoire in a few years, and the realignment of corporate services with IITA that is currently underway. Management is aware of these matters, is taking concerted action to respond to some of these concerns, and is expected to take further steps as needed. The Panel's report discusses these issues, and makes a few suggestions and recommendations which we hope will help address the key staff- and management related issues during the next few years.

***Recommendation 12: The Panel recommends that WARDA fills vacant positions within the shortest time possible in order to ensure efficiency of program implementation.***

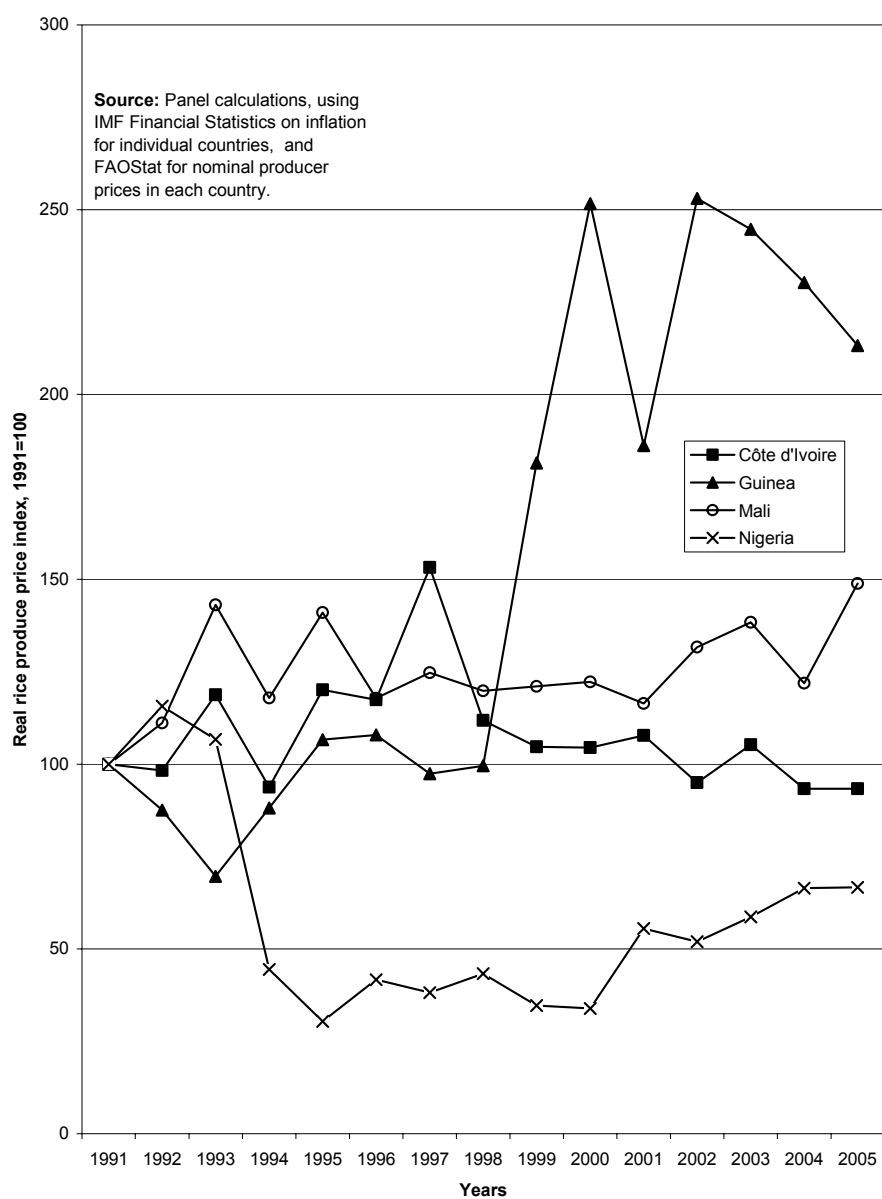
**WARDA's 2000 Response:** WARDA agrees and will continue to endeavour to fill vacant positions within the shortest time possible without compromising quality of the appointment.

**WARDA's 2007 Updated Response:** While it is agreed that it is important for WARDA to continue filling vacancies within the shortest time possible, without compromising quality of the appointment, it is equally important for WARDA to manage these vacancies as efficiently as possible. The crisis in Côte d'Ivoire has taught WARDA that it is better to recruit quality and committed staff that will stand by the institution than those who may be tempted to abandon the ship at the smallest wind. During the period in review, a total of XX positions have been filled with an average length of XX months of vacancy.

**Panel's Comments:**

The Panel agrees with WARDA's updated response of 2007 that vacancies need to be filled expeditiously without compromising quality. It expects Management will continue to seek the best qualified persons for filling current and future vacancies, and will follow established recruitment policies and procedures in a fair and transparent manner.

# **Annex VIII** **Evolution of real rice prices to producers in Africa's main rice producing countries** **1991-2005**



## ANNEX IX

### The Ivorian crisis

The “Ivorian crisis” developed suddenly in late September 2002 and spread rapidly in 2003-04. WARDA Management responded with a series of short-term as well as long-term mitigating strategies. A brief account of the main events that unfolded during the first year of the crisis is given below, to provide an appreciation of the difficult situation faced by the Center at the beginning of the review period covered in this report (since the last EPMR in 2000).

The crisis started on 19 September 2002, following a coup attempt by rebel forces in Côte d’Ivoire. The area in and around Bouaké, where the Center’s headquarters and most of its staff were located, soon became the epicenter of armed conflict. WARDA staff were unable to leave their homes for over a week; but after strenuous efforts by Management to ensure safe passage out of Bouaké, on 26 September 2002 WARDA was able to relocate about 250 staff members to Abidjan. This group included all internationally recruited staff (IRS), and most general services staff (GSS) who, as per the host country agreement, had been recruited not only from Cote d’Ivoire but also from other West African countries.

The majority of IRS remained in Abidjan, where a temporary administrative base was established by WARDA Management; and most IRS families were evacuated from Côte d’Ivoire. These decisions were endorsed by the Chairs of the Board of Trustees and the Council of Ministers. On 1 November 2002, ICRISAT (CGIAR Center headquartered near Hyderabad in India) agreed in principle to allocate offices to WARDA at its field station in Bamako, Mali. Management therefore moved speedily to relocate and reestablish itself, on a temporary basis, in Mali. In November, after several dangerous forays into M’bé, WARDA staff succeeded in recovering all its data-servers, 25 personal computers, important documents, and some personal effects from the headquarters site; and by 13-16 December, over 6000 accessions, including new collections and breeding lines (80% of the total germplasm collection at M’bé), had been retrieved.

The 2002 field trials and seed multiplication plots were maintained at M’bé; and the end-of-season research work at various other field sites was continued. On 10 January 2003, negotiations with the Government of Mali and ICRISAT were concluded; and by end-February, 16 scientists (60% of the 30 international staff on board in September 2002), and many technical support staff, had been temporarily relocated to Bamako. The WARDA Board meeting decided on 24-28 February 2003 that the Center should plan to stay in Mali for at least two years--thus activating a long term strategy of crisis management that allowed scientists the necessary timeframe for research planning and implementation, as well as planning their personal life.

By end-February 2003, a shipment of recovered germplasm accessions had been sent to IITA (at Ibadan, Nigeria), with a duplicate batch retained in Abidjan. The Management team, and the Administration and Finance department operated from the Abidjan Liaison Office; and organized frequent meetings of the Executive Management Team (EMC) and meetings with scientists and other staff. WARDA’s research and development activities at field stations in St Louis (Senegal) and in Ibadan were not affected, largely due to WARDA’s partnership mode of operations. On 4 March 2003, a host country agreement was signed with the Government of Mali.

During the same period, WARDA staff recovered all germplasm material from M’be, totaling 7,500 accessions. One set of samples was preserved in Abidjan and another was sent to IITA, where WARDA’s long-term storage of its germplasm is traditionally maintained. WARDA also reached agreement with Fort Collins, Colorado, on safety duplication of the germplasm. In addition, to ensure business continuity, WARDA’s Information and Communication Technology (ICT) unit was

particularly proactive throughout the crisis. Vital facilities, such as servers and data were retrieved from Bouaké; and new servers for email, finance, and data were installed in Abidjan. A new coordinator of the African Rice Initiative (ARI) was recruited in March 2003.

Despite these achievements, the impact on WARDA was severe. The Director General reported to the Board in February 2003 that “the crisis has dealt a heavy blow to WARDA’s research activities. Some of WARDA’s output can be retrieved but a lot of scientific effort has been lost. The long-term trials have especially suffered.” Several scientists had left the country when the unrest began; and were put on technical leave. The scientists who stayed back in Abidjan had been working without laboratories and fields. Technical and financial reports to donors had been delayed, largely because of the crisis. However, the DG also noted that “our modus operandi of partnership has kept our R&D activities outside of Cote d’Ivoire undisturbed”.

On 2 May 2003, the opposing forces in Cote d’Ivoire signed a Peace Agreement, which included a cease-fire and end of all hostilities. This Agreement was expected to go into immediate effect. By the time the Council of Ministers met on 18-19 Sept 2003 in Cotonou, Benin, there seemed to be grounds for cautious optimism. The Council lauded decisions taken by Management to ensure security of staff, campus, genebank, scientific/financial/administrative data; continuity of operations, communications, and research activities; availability of funds for the extraordinary expenses related to the crisis; continued goodwill and confidence of WARDA’s stakeholders; and maintenance of staff morale and efficiency.

However, it also recognized the continuing negative effects of the crisis: tremendous strain on the Management and staff; disruption of research activities; disruption of family life, which affected staff morale (and led to several resignations); delay in the recruitment for several key staff positions; delay in payment to GSS; severe downsizing of staff, with over 50% of GSS on technical leave; and excessive and extraordinary expenses related to the involuntary dislocation caused by the crisis. Accordingly, the Council concluded that the “decision on the official full-fledged return to Bouaké will be determined only after the disarmament of forces and the establishment of law and order in Bouaké.”

A partial return to M’bé near Bouaké was attempted in September 2004, when again hostilities broke out, particularly in Bouaké on November 2004. This meant the second retreat from M’bé. It is to be noted that when WARDA returned to its headquarters in September 2004, the Board of Trustees in its April 2004 meeting had approved the Plan of Return and all the necessary approvals and assurances were given from the government of Côte d’Ivoire, the United Nations and the international community. When on November 4, 2004 hostilities resumed unexpectedly, most staff from Bamako and Abidjan had already made it back to Bouaké. The death of one of their colleagues which occurred on November 6, 2004 and the violence in Bouaké forced once more an evacuation from Bouaké, then Abidjan and Côte d’Ivoire. This caused a serious disruption in programs and in morale and staff resignations at all levels. The quality of the outputs from the Center need to be maintained by ensuring that staff can work almost worry-free and as a consolidated team in one location. In January 2005, WARDA temporarily located at the IITA-station in Cotonou, Bénin, where it is still now, awaiting a return of stable peace in Côte d’Ivoire.

**ANNEX X (a)**  
**Visit to Senegal**

**24 to 26 June 2007**

**Brigitte Courtois, Zelia Menete, Eric Tollens**

The purpose of this visit was to visit WARDA station in N'diaye, in the Senegal river valley and to discuss with WARDA's various stakeholders: ISRA, SAED, FEPRODES (NGO).

Senegal rice consumption is presently close to one million t per year, for 150,000 – 200,000 t of production, with imports of 700,000 – 800,000 t. Consumers' preferences go to broken rice, well adapted to the national dish, cheap to import, but it seems that there is a growing market for higher quality rice.

The Senegal president has decided that Senegal should be self-sufficient in 2015. This decision put a very high pressure on rice research and production. A self-sufficiency national program was launched in 2006. Most Senegalese rice production comes from the Senegal river valley, where irrigated rice is grown. It is understood that 90% of the expected production increase will come from this area. In this perimeter, rice is grown for sale in the market. It is mostly direct seeded (90% of the area), highly intensive (average yield during the rainy season of 5.5 t/ha) and mechanized.

Among the 500,000 t of rice needed in 2012, the irrigated perimeter will have to produce 350,000 t (to be compared to the present 150,000 t). This perimeter covers 30,000 ha with 27,000 to 28,000 devoted to rice during the rainy season. According to SAED management, this sharp production increase will be obtained through increases in the cultivated area (need for land developments), in production intensification, and in productivity. Water and land availability are not presently a problem in this area.

Increase in production intensification may be seen as a way through which a lot of progress can be made since only 15 to 30% of the rice area is doubled-cropped in rice (4,000 to 10,000 ha). There are several limits to these projections:

- Rice can be grown only during 9 to 10 months in the year because the remaining months (cold dry season) are too cold. For this reason, the calendar is very tight at the time of the harvest of the dry season crop and the seeding of the wet season crop. The lack of operational combine harvesters and other mechanical implements is adding to the intensity of the problem. Early dry season varieties are needed (only Sahel 108 presently available). "Double cropping" often means two crops grown on different plots because of field operation delays. Part of the problem is also economic: the harvest has to be sold to be able to purchase inputs for the next crop (no loan otherwise).

During the hot dry season, rice competes with other crops (vegetables) economically more interesting and shorter in duration (less cropping calendar problems). Present environmental issues are taken into consideration. The rice growing area is divided into 4 agro-ecological zones and while constraints may differ in the different zones, the major one concerns mostly land degradation through salinisation and alcalinisation. More global or future environmental issues, such as methane emission due to irrigated rice, do not come high into the priorities given the overall production increase requested.

Since production is for sale, production costs are scrutinized and cost reduction is an important issue in technology development. Quality is also an issue: quality of the product and post-harvest technology.



Taken into consideration the constraints indicated above, the presence of WARDA stations makes sense. The main WARDA station is small (4 scientists and a total of 25 staff) but with an efficient multidisciplinary team doing good work (research activities assessed in the thematic part of the EPMR report). The second WARDA station in the middle valley has just 4 staff members. Expectations from the stakeholders are huge. Addressed directly to WARDA, they tend to bypass ISRA. An example of efficient collaboration, quoted several times as exemplary, is the ASI thresher collaboratively developed by ISRA, WARDA and SAED that was delivered in 2 years. The fate of the harvester under development is seen with more scepticism because of funding ups and downs. The long time needed for varietal official release, whatever the source of the delay, is also seen as a major impediment for proper seed production. Administrative slowness at all levels is felt as a brake to improvement in rice production (SAED, FEPRODES).

We only heard compliments on WARDA's work from the various stakeholders and everyone indicated how beneficial the collaboration was. All people met also wished to strengthen their collaboration with WARDA. These elements of satisfaction and ownership have to be put at WARDA's credit and the past and present local teams have to be congratulated. The panel felt that the relationships were excellent, to a point that they may carry the risk of too high expectations. WARDA is expected, even by ISRA, to take over whenever ISRA has not the resources to deliver (e.g. ISRA does not have a rice breeder for the river zone because WARDA has one). It will be very difficult to meet the president's expectations, to say the least. Nevertheless the Senegal river area is certainly a very interesting laboratory for WARDA to demonstrate its ability to contribute to high rice productivity in Africa.

Discussions were held with the IVC coordinator based in CERAAS in Thiès concerning lowland areas. IVC started late in Senegal and is still in the characterization phase. The collaborative project with WARDA concerns the development of salted lowlands from Sine Saloum with land reclamation from salinity and acidity.

CORAF/WE CARD is present in Dakar and the Panel met its scientific coordinator. CORAF changed its way to operate, focusing on programs to limit the negative impact of short-term project-based funding. The Panel members felt that potential competition on network leadership could be a source of tension between CORAD and WARDA. The scientific coordinator regretted the absence of Nigeria in the first phase of ARI, while it has a strong private sector that could invest in seed production.

**ANNEX X (b)**  
**Visit to Mali**

**29-30 June 2007**

**Brigitte Courtois, Zelia Menete, Eric Tollens**

The purpose of this visit was to discuss with IER and its various stakeholders such as Office du Niger about the collaboration with WARDA. The panel went to Ségou to discuss with Office du Niger staff, and to Niono to see one of the main IER rice stations. We had the opportunity to discuss with a group of farmers in the village of Nango about the main constraints to rice production.

Office du Niger manages a perimeter of 80 000 ha irrigated by gravity from a dam on the Niger river. The demands for settlement on government developed plots are huge. The plot attribution went down from an official 3 ha to 0.25 ha in some cases which creates problem of mechanization. Office du Niger try to encourage private investors to settle large farms (100 to 500 ha) with little success so far (too high costs of development for privates).

Rice is grown during the rainy season. It is highly intensive (5.0 t/ha) transplanted rice. According to farmers, the main constraints to production are price and quality of fertilizers, increase in disease pressure, lack of farmers' organization to put a pressure on rice buyers, poor quality of rice transformation with small machines that induce a large proportion of broken rice, invasion of the canals by aquatic plants.

Rice is sometimes grown during the dry season but the yield expectations are lower (around 3 t/ha). It is never double cropping but rice grown on different plots. The constraints in terms of cropping calendar are very similar to that encountered on the Senegal river.

Everyone seems happy with the range of varieties available. Those are old varieties well adapted to the local conditions although some people mentioned the increased damaged of RYMV on BG90-2. Gambiaka, the oldest one, is a reference for grain quality.

There is a strong sense of ownership toward WARDA. As in Senegal, relationships with the various stakeholders seem excellent. IER scientists count a lot on WARDA for support and training. The way WARDA left Mali in 2004 was not diplomatic and was not appreciated.

We visited the molecular marker lab in IER. It has been recently installed and has not been used yet. Two persons from IER have been trained in Cotonou. Attention has to be paid to train people to safety procedures in waste management, and to damage control (e.g. in case of broken equipment). The panel commands the fact that molecular marker labs are now set on breeding sites, but want to stress that only very robust techniques can be used in such conditions.

**ANNEX X (c)**  
**Visit to Uganda**

**Zelia Menete and Eric Tollens**

**11-15 June, 2007**

**Status of NERICA Dissemination in Uganda**

At least 85% of the Ugandan population, currently 27.2 million people, is dependent on agriculture. Coffee, cotton, tea and tobacco are the key traditional exports. Commercial crops include flowers, rice, maize and sugarcane. Rice used to be a ceremonial food, but now current rice consumption is around 200.000 t with about 50.000 t imported. And demand continues to grow rapidly which offers opportunities for import substitution. Rice is a profitable crop for smallholders - the rice sector provides an opportunity to generate income and employment in rural and urban areas and thereby revitalizes local economies.

No rice research was taking place in Uganda until 1993 and the sector relied on irrigated areas for production. After 1993, Uganda worked with North Korean scientists, IRRI and IITA for improving lowland varieties. In 1996, testing of WARDA WAB series started at NARO but after a RYMV attack at Tilda government farm in 1998, the focus shifted to upland NERICAs and Nerica 4 (also called locally Suparica 2 and NARIC 3) was released along with ITA 357 and ITA 325. Upland rice production really took off in 2000 following the development of formal and informal seed multiplication companies, technology transfer projects, input and credit delivery systems. With the rapid upland NERICA uptake by farmers, rice became a priority crop receiving Government support, in particular from the Office of the Vice-President since 2004. NARO has Nerica 1 and 10 ready to be released and research on drought tolerance, weed, pests and fertilizer management options is ongoing. Presently, new germplasm testing includes WARDA's lowland NERICAs. Short-term training in improved rice production is occurring through ECARRN.

Although reliable statistics do not exist, area under rice is about 120.000 ha, with the area under NERICA between 25 to 35 thousands ha. Yields vary from 2 to 5 ton/ha depending on the ecology as upland varieties are also grown in the rainfed lowlands. The upland cultivation has expanded to fragile areas. The private sector is very vibrant and pro-active in the rice sector in Uganda. For example, there are three rice seed companies (FICA, NASECO and Victoria seeds) and several companies are active in marketing, packaging and branding. Suppliers provide fertilizers, weed control options, labor saving and post-harvest equipment to farmers. NGO's are mainly involved in technology transfer and training. There is strong support from USAID through APEP (Agricultural Productivity Enhancement Project), from the Danida financed ASPS (Agricultural Sector Programme Support) and through Sasakawa-Global 2000. However, post-harvest and handling problems persist in affecting rice quality resulting in a small discount for local rice as compared to imported rice, which sells at retail at close to one USD per kg. In addition, weak seed certification, striga infestation due to low soil fertility and threshability of Nerica 4 are problems that need to be addressed urgently to sustain the encouraging results in rice cultivation, and particularly the NERICA 4 variety.

Rice research and training are based at the National Crops Research Institute in Namulonge. The team is very small with input from a JICA specialist and technicians. Japan has been supporting strongly rice sector development in Uganda. Japan is also funding a two year FAO project for the dissemination of NERICAs with the farmer field schools approach. A MoU between WARDA and NARO was signed in 2003. The Government of Uganda has applied for membership of WARDA, which is due for discussion at the Council of Ministers meeting in September 2007.

Factors contributing to the expansion of areas under NERICA are the existence of public-private partnerships, a market driven approach linking producers to processors, technology generation and transfer, better input delivery systems and the profitability of rice production backed by Government support and favorable rice policies e.g. 75 % import duty (common external tariff) on imported rice. This strongly indicates that strengthening research, extension, training and other supporting systems for the whole value chain, including a favorable policy environment, are the key to the success of the NERICA dissemination.

**ANNEX XI Staff time allocation for each project and discipline**

				Percent of WARDA's staff member's time allocated to each project in 2006										
				Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
Last Name	First Name	Discipline	Position Title	Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Agboh-Noameshie	Rita Afiavi	Agronomy / NRM	SWIHA Coordinator (Consultant)						10	40		20		100
Ajayi	Olupomi	IPM/ Entomology	Coordinator					10		30			60	100
Akintayo	Inoussa	Agronomy / NRM	ARI-Coordinator	20				20		60				100
Attiogbevi-Somado	Eklou	Agronomy / NRM	Agronomy-GR and Seed					10	20	70				100
Bado	Vincent	Agronomy / NRM	Head of Sahel Regional Station		15	35					5		45	100
Bruce-Oliver	Samuel	IPM/ Entomology	Executive Officer - DGO	0	0	0	0	0	0	0	0	0	100	100
Coulibaly	Pefery	Admin	IT Manager	0	0	0	0	0	0	0	0	0	100	100
De Vries	Michiel	Agronomy / NRM	Agronomist		10	60					30			100
Diagne	Aliou	Ag. Economics	Agric. Economist	40				50		10				100

				Percent of WARDA's staff member's time allocated to each project in 2006										
				Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
Last Name	First Name	Discipline	Position Title	Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Diatla	Sitapha	Agronomy / NRM	Soil Chemist, ag. WARDA Rep, CI							30			70	100
Futakuchi	Koichi	Physiology	Crop Ecophysiology	30	50		20							100
Geerts	Koen	Admin	ADG-CS	0	0	0	0	0	0	0	0	0	100	100
Hotobah-During	Samira	Admin	Head of Donor	0	0	0	0	0	0	0	0	0	100	100
Ikeda	Ryoichi	Genetic improv/ molecular bio	Seed Multiplication specialist	20	10					70				100
Katuli	Nurdin	Admin	Head of OSA	0	0	0	0	0	0	0	0	0	100	100
Keya	Okoth Shellemiah	Agronomy / NRM	ADG-R&D	0	0	0	0	0	0	0	0	0	100	100
Kiepe	Paul	Land & Water Management	NRM Specialist, IVC Coordinator, Head GIS, Program 2 Leader						30		50		20	100

				Percent of WARDA's staff member's time allocated to each project in 2006										
Last Name	First Name	Discipline	Position Title	Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
				Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Kroma	Margaret	Other Social Sciences	Visiting Scientist-Rural Sociology					50	25	10		10	5	100
Lisette-Vidal	Aline	Comm / Extn / KM	Head, Library & Information	0	0	0	0	0	0	0	0	0	100	100
Luzi-Kihupi	Ashura	Genetic improv/ molecular bio	Regional Coordinator	15						35			50	100
Maina	George	Admin	Head of finance	0	0	0	0	0	0	0	0	0	100	100
Manneh	Baboucar	Genetic improv/ molecular bio	Molecular Biologist	25	15		60							100
Meijs	M.G.J. Marcel	GIS	GIS/Water Management Specialist						50		50			100
Millar	David	Comm / Extn / KM	Science Writer	1,5	2	0,5	0	2,5	2	1	0,5	10	80	100
Mohapatra	Savitri	Comm / Extn / KM	Communications Officer	0	0	0	0	0	0	0	0	0	100	100

				Percent of WARDA's staff member's time allocated to each project in 2006										
				Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
Last Name	First Name	Discipline	Position Title	Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Narteh	Lawrence	Agronomy / NRM	Network Coord	10	10					80				100
Ndjiondjo-Nzenkam	Marie-Noelle	Genetic improv/molecular bio	Molecular Biologist	15	10		60			15				100
Nwilene	Francis	IPM/Entomology	Entomologist/Liaison Scientist	35	50	15								100
Oikeh	Sylvester	Agronomy / NRM	Cropping Systems Agronomists	50	35				15					100
Olatifede	Kola	Admin	Budget Manager	0	0	0	0	0	0	0	0	0	100	100
Rodenburg	Jonne	Agronomy / NRM	CSA	15		15					70			100
Saito	Kazuki	Physiology	Physiologist		50	50								100
Samejima	Hiroaki	Agronomy / NRM	NRM		40	40		20						100
Sanchez	Ines	Genetic improv/molecular bio	Population Genetics & Evolution	15			15			70				100



				Percent of WARDA's staff member's time allocated to each project in 2006										
				Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
Last Name	First Name	Discipline	Position Title	Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Seck	Papa Abdoulaye	Ag. Economics	DG	0	0	0	0	0	0	0	0	0	100	100
Semon	Mande	Genetic improv/ molecular bio	Upland Rice Breeder	50	10		40							100
Séré	Yacouba	IPM/Entomology	Plant Pathologist	25	40	30							5	100
Sie	Moussa	Genetic improv/ molecular bio	LowlandRice Breeder	15	60	15					10			100
Sokei	Yoshimi	Physiology	Agronomist	10	10					80				100
Tia	Dro Daniel	Genetic improv/ molecular bio	GR Specialist	20					10	70				100
Traore	Karim	Genetic improv/ molecular bio	Irrigated rice Breeder	5	30	65								100

				Percent of WARDA's staff member's time allocated to each project in 2006										
				Project 001	Project 002	Project 003	Project 004	Project 005	Project 006					
Last Name	First Name	Discipline	Position Title	Enhancing productivity	Sustainable intensification	Enhancing performance	Mitigating drought	Rice policy and technology impact	Mitigating human and environmental effects	Networks Partnerships : ARI, ECARRN, ROCARIZ	IVC	SWIHA	Management /admin. support to all projects	Total
Tsunematsu	Hiroshi	Genetic improv/molecular bio	Geneticist-Associate Upland Breeder	20			80							100
Van Mele	Paul	Comm / Extn / KM	TT Agronomist					15		65	20			100
Youm	Ousmane	IPM/Entomology	Asst. Director R&D	20									80	100

Source: WARDA

# ANNEX XII

Number of journal articles published by WARDA scientists per years. Impact factor (average 2002-2004)  
and Rank in the discipline of these journals.

Journals with impact factor	2000	2001	2002	2003	2004	2005	2006	Impact factor*	Rank 2003
African Entomology					1			0.480	0.49
Agric, Ecosystems Environment		2	1	2			1	1.340	0.66
Agricultural Economics	1	1			1			0.654	0.40
Agricultural Systems			1	2			2	0.912	0.54
Agricultural Water Management			1		1			0.791	0.35
Agroforestry Systems					1			0.638	0.39
Agronomie			1					0.679	0.34
Agronomy Journal				1	1	1		1.118	0.81
Animal science			1					0.924	0.89
Biological Control		1						1.215	0.93
Biology and Fertility of Soils	1	2					2	1.223	0.89
Comm in Soil Sci and Plant Anal	5	2	1	2				0.403	0.48
Crop Protection				2	1	1		0.865	0.52
Crop Science							1	0.827	0.73
Euphytica	1			1	1		2	0.734	0.61
European J Agronomy		1	2	1				1.140	0.79
European J Plant Pathology						1		1.373	0.92
Experimental Agriculture					3			0.414	0.43
Field Crop Research	1	2	1	2	2	5	2	1.191	0.78
Food Policy			1		1	1		0.561	0.38
Genetics						1		4.299	0.81
Genome							1	1.925	0.67
Geoderma	1		1		2		1	1.282	0.83
Hydrological Processes				1				1.260	0.68
Int J Pest Management	2	1	3					0.556	0.23
J Agric Rural Dev Trop Subtrop					2			0.028	na
J Agricultural Economics					1			0.468	0.49
J Applied Entomology		1						0.459	0.56
J Exp Botany	1							3.133	0.91
J Plant Nutrition	1							0.495	0.49

Journals with impact factor	2000	2001	2002	2003	2004	2005	2006	Impact factor*	Rank 2003
J Plant Nutrition Soil Science			1			1	1	0.953	0.66
J Plant Physiology	1							1.048	0.79
J Science of Food and Agric					1		1	1.086	0.88
J Sustainable Agriculture		1		1	1		1	0.184	0.20
J Virology					1			5.288	0.94
Land Degradation Development					1			0.794	0.50
Maydica				1				0.474	0.52
Molecular Ecology						1		3.753	0.92
Nematology	1							0.692	0.76
Nutrient Cycling Agroecosytems		2			1	4		0.754	0.76
Outlook on Agriculture					1	1		0.318	0.37
Physiol and Mol Plant Pathol		1						1.329	0.86
Plant and Soil	2				1	1	1	1.475	0.86
Plant Mol Biol			1					3.945	0.97
Plant Pathol J							1	1.299	0.70
Plant Production Science							1	0.416	na
Seed and Science Technology			1					0.461	0.17
Soil and Tillage Research			1	1			1	1.221	0.75
Soil Use and Management						1		1.161	0.77
The Plant Journal							1	6.044	0.98
Theor Appl Genet	1			2				2.511	0.98
Tropical Medicine Int Health		1		2				1.974	0.66
Weed Research							1	1.204	0.63
<b>Total</b>	<b>19</b>	<b>18</b>	<b>18</b>	<b>21</b>	<b>25</b>	<b>19</b>	<b>21</b>		

Journals with no impact factor	2000	2001	2002	2003	2004	2005	2006
Acid Soil Res and Rehabilitation	1						no
Acta Agronomica Hungarica			1				no
African Crop Science J			1				no
African Insect Science Bulletin	1						no
African J Biotechnology						4	8 no
Afrique Science						1	no
Agriculture and Horticulture							1 no
Agric and Food Sci J of Ghana				1			no
Agronomie Africaine		1		1	2	3	no
Asian J Plant Sciences					1	1	2 no
Autrepart					1		no
Biocontrol News and Information		1	1				no
Bull Entomol Research	1						no
Cahier Agricultures	3	1			1	1	no
Development Policy Review					1		no/?
Economic Dev Cultural Change	1						no/?
Economic Review		1					no
Farming Japan			1				no
Ghana J of Agricultural Science							1 no
Insect Science and its Application	1	1					no
Int Coop Agric Forestry (Jpn)	1						no
Int J Agricultural Sustainability				1	1		1 no
Int J Nematology	1						no
Int J Tropical Insect Science							1 no
Int Rice Commission Newsletter		1				1	1 no
Int Rice Research Notes	2						1 no
Int Sorghum Millets Newsletter					2		no
J Agric Environment	1						no
J Agronomy and Crop Science					1		no
J Breeding and Genetics						1	no
J Exp Agriculture			2				no
J Indian Society Soil Science	2						no
J Plant Disease and Protection			1				no

Journals with no impact factor	2000	2001	2002	2003	2004	2005	2006	
J Science and Technology Ghana					1			no
Jpn J Crop Science		1						no
Jpn J Food Sci and Technology	1		1					no
Jpn J Rural Economics				1				no
Jpn J Tropical Agriculture		2	1					no
KM4D Journal							1	no
Land Use Policy				1				no
Netherland J Agric Science				1				no
New Agriculturist			1					no
Nigerian J of Science					1			no
Oryza	1				1			no
PLA Notes			1					no
Sahelian Studies and Research					1			no
Savanna J Sci and Agric							1	no
Sekai no Norin Susai							1	no
Shokucho					1			no
Sumaru J Agric Research		1	1					no
The Developing Economies							2	no
The Modern Language						1		no
Tropical Science	1	2						no
Uganda J Agric Science						1		no
W Africa Seed Planting Material	1							no
Wageningen J Life Sciences			1					no
World Development				1				no/?
World J Agric Sci							1	no
Total	19	12	13	7	15	14	22	
Overall total	38	29	31	28	39	33	43	

**Annex XIII**

**WARDA's Funding Structure, 2000-2006 (US\$ Thousands): Restricted vs Unrestricted Grants**

	2000	2001	2002	2003	2004	2005	2006
<b><u>Unrestricted Grants</u></b>							
Belgium	162,069	131,780	147,565	182,301	166,065	229,890	245,271
Canada	470,212	452,828	442,655	574,248	701,067	692,446	505,214
Denmark	126,199	109,311					
France	141,000	148,000	161,385	75,562	95,640	89,026	95,645
Germany		140,403	140,655	175,065	185,295	194,285	192,132
Japan	654,340	412,990	804,762	1,029,012	1,120,039	897,249	737,965
Netherlands	704,920	642,008	665,731	792,036	892,771	918,612	867,000
Norway	255,807	241,434	360,000	526,774	588,365	768,255	654,688
Sweden	336,344	319,041	357,916	416,536	514,018	454,400	426,279
United Kingdom	268,434				616,438	639,363	914,800
USAID	250,000	224,991	225,000	225,000	225,000	200,000	200,000
World Bank	1,310,000	1,390,000	1,080,000	760,000	700,000	747,500	1,086,000
Cote D'Ivoire		59,836	41,086				
<b>Total Unrestricted Grants</b>	<b>4,679,325</b>	<b>4,272,622</b>	<b>4,426,755</b>	<b>4,756,535</b>	<b>5,804,697</b>	<b>5,831,025</b>	<b>5,924,993</b>
<i>Special Transition Grant Incomes (Crisis Related) :</i>							
World Bank			180,087	1,221,243	430,000		
United Kingdom						143,400	
Japan						40,000	
<b>Total Unrestricted and Special Grant Revenues</b>	<b>4,679,325</b>	<b>4,272,622</b>	<b>4,606,842</b>	<b>5,977,778</b>	<b>6,234,697</b>	<b>6,014,425</b>	<b>5,924,993</b>
<b>Total Restricted Project Grants</b>	<b>3,407,242</b>	<b>4,796,839</b>	<b>5,158,657</b>	<b>4,411,405</b>	<b>4,220,726</b>	<b>5,191,938</b>	<b>5,034,582</b>
<b>Sub-Total Unrestricted and Restricted Grant Revenues</b>	<b>8,086,567</b>	<b>9,069,461</b>	<b>9,765,499</b>	<b>10,389,183</b>	<b>10,455,423</b>	<b>11,206,363</b>	<b>10,959,575</b>
<i>Other Revenues:</i>							
Member States:	297,928	147,505	135,117	72,776	313,378	54,849	113,597
Center Earned Income:	405,881	566,330	374,842	278,762	70,385	160,048	363,300
<b>Total Grant and Other Revenues</b>	<b>8,790,376</b>	<b>9,783,296</b>	<b>10,275,458</b>	<b>10,740,721</b>	<b>10,839,186</b>	<b>11,421,260</b>	<b>11,436,472</b>

ANNEX XIV  
WARDA'S 5th EPMR: Staff Perceptions Survey

**Respondent Information:**

1. When joining WARDA you were: *Internationally recruited/Nationally recruited*
  2. During your work at WARDA you spend most of your time doing: *Administration/Research/Tasks to Support Administration/Tasks to Support Research/Other*
- 

**Questions:**

Please select one of the following five possible responses for questions 1 to 24. The final part of the questionnaire invites you to freely comment on further issues you chose to raise.

- i. Agree strongly
  - ii. Agree somewhat
  - iii. Disagree somewhat
  - iv. Disagree strongly
  - v. No opinion
1. WARDA's "new vision" for moving forward is shared by you.
  2. WARDA's "new vision" for moving forward is shared by a great majority of the staff.
  3. WARDA provides an environment conducive to innovative research.
  4. WARDA's arrangements for the management of research are effective and inclusive.
  5. WARDA's administrative and management systems are supportive of your work.
  6. The decentralized system of research at WARDA works well.
  7. Staff-management relations at WARDA are good.
  8. WARDA provides a good overall work atmosphere.
  9. The performance management process provides good supervision and allows you to perform your best.
  10. Reports on project income and expenditure allow effective control of budget.
  11. Reports on project income and expenditure are provided to you in a timely fashion.
  12. The purchasing/administrative services provide items at prices that are competitive in the market.
  13. The purchasing/administrative services provide items in a timely fashion.
  14. Job opportunities at WARDA attract the highest quality staff.
  15. There are good opportunities for professional advancement at WARDA.
  16. The appropriately trained support staff is available to allow good quality research.
  17. The corporate services alignment process with IITA has been an issue open for discussion by all WARDA staff.
  18. The alignment of WARDA and IITA corporate services will be good for WARDA.
  19. The alignment of WARDA and IITA corporate services will be good for you.
  20. The programmatic alignment with CIAT and IRRI has been an issue open for discussion by all WARDA scientific staff.
  21. The programmatic alignment of WARDA with CIAT and IRRI will be good for WARDA.
  22. The programmatic alignment of WARDA with CIAT and IRRI will be good for you.
  23. WARDA's management of successive relocations of its Headquarters was appropriate.
  24. Inputs from individual researchers are taken into consideration by management.
25. Please briefly write any further comments you would like raised with the Panel:
-



**ANNEX XV**  
**Africa Rice Center (WARDA) Stakeholder Survey**

Please disregard this questionnaire if you consider that you are not sufficiently familiar with the Africa Rice Center (WARDA).

**Respondent information:**

Please mark the type of organization that most closely describes your organization:

- National agricultural research institute [ ]  
 University [ ]  
 Advanced research institution other than university [ ]  
 Non-governmental civil society organization [ ]  
 Non-governmental farmer organization [ ]  
 Private company [ ]  
 Government department or institute [ ]  
 Other [ ]  
 Explain.....

Country where your organization is located:

Your organization is related to WARDA as a: donor [ ]; partner [ ]; partner and donor [ ]; user of WARDA's products and services [ ]; other: .....

**Questions:**

1. What is your assessment of WARDA's performance, measured by delivery of useful (high-quality and relevant) research in the areas listed below? Please tick one option for each area.

	excellent	good	fair	poor	no opinion
<b>RAINFED UPLAND RICE SYSTEMS</b>					
Producing improved lines and varieties of good quality with higher and stable yield					
Provided integrated management options for weeds, pests and diseases					
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)					
<b>RAINFED LOWLAND RICE SYSTEMS</b>					
Producing improved lines and varieties of good quality with higher and stable yield					
Provided integrated management options for weeds, pests and diseases					
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)					
<b>IRRIGATED LOWLAND RICE SYSTEMS</b>					
Producing improved lines and varieties of good quality with higher and stable yield					
Provided integrated management options for weeds, pests and diseases					
Provided integrated management options for stress resistance (soil fertility and toxicity)					

Designed rice policy options for promoting viable rice seed production and distribution systems					
Designed rice policy options for promoting competitive rice production and marketing systems					
Designed and disseminated viable post-harvest technologies					
Developing technology transfer approaches					

2. If you are not exclusively a donor, and are also a WARDA partner, please assess WARDA's work in relation with the work of your organization in the areas listed below. Please tick one option for each area.

	competing / repeating	complementing	no opinion
<b>RAINFED UPLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)			
<b>RAINFED LOWLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)			
<b>IRRIGATED LOWLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (soil fertility and toxicity)			
Designed rice policy options for promoting viable rice seed production and distribution systems			
Designed rice policy options for promoting competitive rice production and marketing systems			
Designed and disseminated viable post-harvest technologies			
Developing technology transfer approaches			

3. Please assess WARDA's work in relation with the work of other organisations that you know, in the areas listed below. Please tick one option for each area Please tick one option for each area and specify the name of the organization.

	competing / repeating	complementing	no opinion
<b>RAINFED UPLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)			
<b>RAINFED LOWLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (drought, soil fertility and toxicity)			
<b>IRRIGATED LOWLAND RICE SYSTEMS</b>			
Producing improved lines and varieties of good quality with higher and stable yield			
Provided integrated management options for weeds, pests and diseases			
Provided integrated management options for stress resistance (soil fertility and toxicity)			
Designed rice policy options for promoting viable rice seed production and distribution systems			
Designed rice policy options for promoting competitive rice production and marketing systems			
Designed and disseminated viable post-harvest technologies			
Developing technology transfer approaches			

4. Please assess your organisation's experience in contributing to WARDA's activities. Please tick the appropriate options for each activity.

	Significantly	Not significantly	Not at all
Priority setting			
Design of research projects			
Ex-ante impact assessment of projects			
Conduction of research			
Adaptation/validation of research results			
Diffusion of research results/technologies			
Training and capacity building			
Advocating policies			
Building and maintaining partnerships			
Ex-post impact assessment			

5. Please assess the actual and preferred balance of WARDA's activities/efforts in the Research for Development Continuum. A Center devoted exclusively to Basic Research would get a value equal to 1, while a Center devoted exclusively to Development Assistance to End-Users would get a value equal to 7. Please tick the box with appropriate value for each row.

	1	2	3	4	5	6	7
Perceived balance of WARDA today							
Preferred balance of WARDA in the future							

6. Please assess WARDA's degree of involvement in improved rice seed production. Please tick the box with appropriate box.

**too much    about right    too little    don't know**

**degree of involvement**

7. Please assess WARDA's degree of involvement in rice policy research and rice policy advice in countries. Please tick the box with appropriate box.

**too much    about right    too little    don't know**

**degree of involvement**

8. In your view, what could WARDA be doing better?  
.....

9. In your view, what is WARDA doing right and should continue to do?  
.....

10. Are there new opportunities within WARDA's mandate that WARDA's research should tackle? If so, describe: .....

11. What recommendations do you have that could improve WARDA's governance and its financial management? .....

12. What other comments would you like to make about WARDA and its programs? .....  
.....

## ANNEX XVI

### Acronyms and Abbreviations

AC	Audit Committee
ACOPCI	Non-governmental organization in Côte d'Ivoire
ADG	Assistant Director General
AEZ	Agroecological zones
AfDB	African Development Bank
AfGM	African Rice Gall Midge
AFLP	Amplified fragment length polymorphism
AGRHMET	Agriculture Hydrology Meteorology Regional Center, Niamey, Niger
AfRGM	African Rice Gall Midge
AMC	Agreement Management Committee
ANADER	Agence Nationale d'Appui au Développement Rural in Côte d'Ivoire
ANHA	African Network on HIV/AIDS
APRAG	Agricultural Policy Research and Advocacy Group
ARC	Agricultural Research Council of Nigeria at Abuja
ARI	African Rice Initiative
ASARECA	Association for Strengthening Agricultural Research in Eastern & Central Africa
ASI	ADRAO/SAED/ISRA Thresher- Cleaner
ATE	Average Treatment Effect Estimation of Adoption
AVRC	Asian Vegetable Research Center
AVRDC	Asian Vegetable Research and Development Center
BAC	Bacterial artificial chromosome
BCF	Back cross line, e.g. in F2
BGBD	Below-ground Biological-diversity
BLB	Bacterial Leaf Blight
BOT	Board of Trustees
CAADP	Comprehensive Africa Agricultural Development Programme
CBFC	Community-based Fish Culture in Irrigated Systems and Seasonal Floodplains
CBSS	Community Based Seed Systems
CCER	Center-Commissioned External Review
CDC	Centre Directors Committee of the CGIAR
CERAAS	Centre de Recherche pour l'Adaptation à la Sécheresse (drought research), Thiès, Senegal
CFC	Common Fund for Commodities (of U.N., based in Amsterdam)
CFA franc	Communauté financière africaine franc (currency used in West and Central Africa)
CGIAR	Consultative Group on International Agricultural Research
CGNET	CGNET Services International, global information networks and communications service provider
CIAT	Centro Internacional de Agricultura Tropical
CIMC	Community Based Integrated Crop Management
CIAT-TSBF	Centro Internacional de Agricultura Tropical-Soil Biology and Fertility Institute
CIDA	Canadian Development International Agency
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CIRES	Centre Ivoirien de Recherche Economique et Sociale, Abidjan
CNRA	Centre National de Recherche Agronomique, Côte d'Ivoire
CNRADA	Centre National de Recherche Agronomique et de Développement Agricole (Mauritania)

CNU	National Coordination Units
COM	Council of Ministers
COPRORIZ	Coopérative des Producteurs de Riz
CORAF	Conseil Ouest et Centre Africain pour la Recherche et le Développement /West & Central African Council for Agricultural Research and Development (WECARD)
CPA	Chartered Public Accountant
CRIL	IRRI-CIMMYT Crop Research Informatics Team
CS	Corporate Services
CSA	Cropping Systems Agronomy
CSC	Consortium Steering Committee [of IVC]
CSO	Civil Society Organization
CSSL	Chromosomal Segment Substitution Line
DB	Data base
DFID	Department for International Development
DG	Director General
DGIS	Netherlands Directorate General for International Cooperation
DNA	Deoxyribonucleic acid,
ECA	East and Central Africa
ECARRN	East and Central Africa Rice Research Network
ECOWAS	Economic Community Of West African States
EC	European Commission
ECSA	East, Central and southern Africa
EFC	Executive and Finance Committee
EMT	Executive Management Team
EPMR	External Programme and Management Review
ESA	East and Southern Africa
ET	Evapotranspiration
EU	European Union
EcCo	Executive Committee of the CGIAR
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FE	Iron
FERRIZ	Model for fertilizer recommendation
FMHS	Farm management household survey
FTE	Full time equivalent
GCP	Generation Challenge Program
GIS	Geographical Information Systems
GMO	Genetically-modified organisms
GPD	Gross Domestic Product
GRU	Genetic resources institute
GSS	General Support Service Staff
GTZ	Gesellschaft für Technische Zusammenarbeit (of Germany)
GxE	Genotype and environment
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HP	Harvest Plus
HR	Human Resources
HQ	Headquarters
IA	Internal Audit or Impact Assessment (see the context)
IAU	Internal Audit Unit (of the CGIAR)
ICARDA	International Center for Agricultural Development in the Dry Areas
ICIPE	International Center for Insect Physiology and Ecology

ICLARM	International Center for Living Aquatic Resources
ICM	Integrated Crop Management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICRM	Integrated crop and natural resources management technologies
ICT	Information and Communication Technology
ICW	Inter-Centre Week meeting of the CGIAR
IDC	Information and Documentation Center
IER	Institut d'économie rurale (NARI of Mali)
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGNRM	Integrated Genetic and Natural Resources management
IHP	Interspecific Hybridization Project
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INERA	Institut de l'Environnement et des Recherches Agricoles
INGER	International Network for Genetic Evaluation of Rice
INRAB	Institut National de la Recherche Agronomique du Bénin
IPG	International public goods
IPM	Integrated Pest Management
IRAG	Institut de Recherche Agronomique de Guinée
IRD	Integrated Resources Development or Institut de Recherches pour le Développement in France (formerly ORSTOM)
IRRI	International Rice Research Institute
IRS	Internationally Recruited Scientists
IRSS	International Research Support Services
IT	Information technology
ISFM	Integrated Soil Fertility Management
ISNAR	International Service for National Agricultural Research (now at IFPRI)
ISO	International Standards Organization
ISRA	Institut Senegalais de Recherches Agricoles
ITC	International Teledetection Centre in Enschede, the Netherlands
IVC	Inland Valley Consortium
IVDRC	International Vegetable Development and Research Center
IVS	Inland valley system
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
K	Potassium
LSU	Louisiana State University
M&E	Monitoring and evaluation
MAS	Marker-aided selection
MDG	Millennium Development Goals
MoA	Memorandum of Agreement
MoU	Memorandum of understanding
MSc	Master of Science
MTP	Medium Term Plan
N	Nitrogen
NARC	National Agricultural Research Center, NARO, Tsukuba, Japan
NARES	National Agricultural Research and Extension Systems
NARI	National Agricultural Research Institute
NARO	National Agricultural Research Organization (Uganda)

NARO	National Agriculture and Food Research Organization (Tsukuba, Japan)
NARS	National Agricultural Research Systems
NC	Nominating Committee
NCU	National Coordinating Units
NEC	National Experts Committee
NEPAD	New Partnership for Africa's Development
NERICA	New Rice for Africa
NGO	Non-Governmental Organization
NIAES	National Institute for Agro-Environmental Sciences, Tsukuba, Japan
NIAS	National Institute of Advanced Studies
NISER	Nigerian Institute for Social and Economic Research
NIVISA	Natioanl Inland Valley Information Systems of Africa
NRM	Natural Resources Management
ORSTOM	French Research Institute for the Tropics , now IRD
OSIRIZ	Observatoire du Marché International du Riz of CIRAD
OVDL	Organisation volontaire du développement local
P	Phosphorous
PADS	Participatory Adaptive Research and Dissemination of Rice Technologies in West Africa
PAM	Policy Analysis Matrix
PASS	Program on African Seed Systems
PBO	Planning and Budget Officer
PC	Program Committee
PCR	Polymerase chain reaction (
PLAR	Participatory Learning and Action Research
PPB	Participatory Plant Breeding
PS	Principal Staff
PVS	Participatory Varietal Selection
PVS-E	Extension-led Participatory Variety Selection
QA	Quality assurance
QTLs	Quantitative Trait Loci
QUEFTS	Quantitative Evaluation of the Fertility of Tropical Soils
R&E	Research and Extension
R&D	Research and Development
RADORT	Research on Accelerated Diffusion of Rice Technologies
RAPD	Random amplified polymorphic DNA
RCU	Regional Coordination Unit
RIDEV	Ddecision tool developed by WARDA
ROCARIZ	Réseau Ouest et Centre Africain du Riz
RS	Remote sensing
RYMV	Rice Yellow Mottle Virus
SAC	Scientific Advisory Committee
SAED	Société d'aménagement et d'exploitation des terres du Delta du Fleuve Sénégal et des vallées du Fleuve Sénégal et de la Falémé (Senegal)
SARC	Sub-Sahara Africa Rice Consortium
SAS	Statistical software
SC	Science Council of the CGIAR
SG 2000	Sasakawa Global 2000
SGRP	Sytemwide Genetic Resources Programme of the CGIAR
SINGER	Systemwide Information Network for Genetic Resources
SMT	Senior Management Team



SNP	Single nucleotide polymorphism
SNRPV	Service National de la Promotion Rurale et de Vulgarisation Agricole (Guinea)
SOPs	Standard Operating Procedures
SP	Strategic Plan
SPIA	Systemwide Program on Impact Assessment
SPIRIVWA	Sustainable Productivity Improvement for Rice in Inland Valleys of West Africa
SRO	Subregional organization
SSA	Sub-Saharan Africa
SSR	Social sciences research
Stata	Software package for statistical analysis
SUN	Financial Accounting Software
SWEP	Systemwide ecoregional programme
SWIHA	Systemwide Initiative on HIV/AIDS and Agriculture
TILS	Training, Information and Library Services
TOR	Terms of reference
TPE	Target population of environments
TSBF	Tropical Soil Biology and Fertility, a division of CIAT based in Nairobi
UEMOA	West African Economic and Monetary Union
UNAIDS	United Nations Aids Organization
UNDP	United Nations Development Programme
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
VAT	Value-added tax
WA	West Africa
WAFRINET	West Africa Network of Taxonomy
WAICENT	World Agricultural Information Centre Portal
WAIVIS	West African Inland Valley Information System
WARDA	West Africa Rice Development Association
WCA	West and Central Africa
WECARD/COR	West & Central African Council for Agricultural Research and
AF	Development/Conseil Ouest et Centre Africain pour la Recherche et le Développement
WB	World Bank
WUR	Wageningen University and Research Centre
Zn	Zinc
4Rs	Regional Rice Research Reviews